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Fabian Herder, Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Ichthyology Section, Adenauerallee 160, 53113 Bonn, Germany, tel. +49 228–9122–255, fax: +49 228–9122–212; f.herder@zfmk.de

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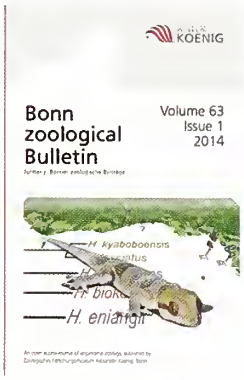

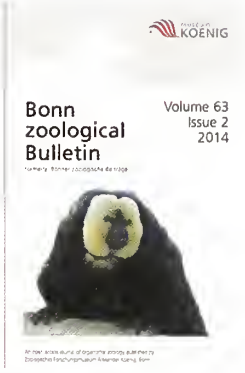

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Morimotodes, a new genus for two minute wingless litter species from southwest China and Taiwan with an illustrated overview of Molytina and Plinthina genera (Coleoptera: Curculionidae: Molytini)

Vasily V. Grebennikov

Canadian Food Inspection Agency, K.W. Neatby Bldg., 960 Carling Ave., Ottawa, ON K1A 0Y9, Canada; E-mail: vasily.grebennikov@inspection.gc.ca

Abstract. The new weevil genus *Morimotodes* g. n. is described for two new species: *M. ismene* sp. n. (Yunnan and Sichuan) and *M. polynices* sp. n. (Taiwan). *Morimotodes ismene* sp. n. is designated as the type species of *Morimotodes* g. n. Species are small (1.6–2.1 mm), wingless inhabitants of leaf litter in montane deciduous forests with characteristically globular body and obliterate elytral striae and dorsal sculpture. Analysis of DNA barcodes and external similarity suggest that *Morimotodes* g. n. is a sister to the West Palaearctic genus *Leiosoma* Stephens, 1829 with 32 similarly small-bodied and litter-inhabiting species. Dated intraspecific phylogeographic analysis utilizing DNA barcodes of *M. ismene* sp. n. reveals seven strongly supported geographical clades, four of which are allopatric and three others are parapatric on Mt. Emei in Sichuan. Potentially allied genera belonging to two of the three Molytinini subtribes, Molytina and Plinthina, are illustrated and briefly discussed. Type specimens of five exceptionally poorly known genera (*Carbonomassula* Heller, 1908, *Clarkanthus* Alonso-Zarazaga & Lyal, 1999, *Gonotrachelus* Champion, 1914, *Vouauxia* Hustache, 1920, *Pterotomus* Quedenfeldt, 1888) are re-examined and the original labels illustrated.

Key words: Yunnan, Sichuan, Taiwan, CO1, DNA barcoding, phylogeography

INTRODUCTION

In 2008, a first long series of conspicuous but unknown beetles was discovered by sifting forest leaf litter on the eastern slope of the Cang Shan Mountain Range in Yunnan (China). The peculiarly small, lustrous and rounded body in combination with the rounded elytral shoulders strongly resembled other litter-inhabiting wingless Palaearctic Molytinae, i.e. *Otibazo* Morimoto, 1961 or *Leiosoma* Stephens (Fig. 7). The subsequent four years of intensive sampling in the same and nearby forests of Southwest China revealed additional similarly shaped specimens. A long series of another seemingly congeneric species was detected among unidentified specimens collected two decades earlier in Taiwan by Aleš Smetana (Fig. 6). The generic identity of these beetles, however, remained elusive.

Since the original discovery in 2008, these beetles were repeatedly compared to many others, mainly belonging to the wingless members of Molytinae. Eventually it became evident that these finds represented a previously undetected clade presumably deserving a formal status of a new genus. This thought intensified the search for its possible relatives. That pursuit was long inconclusive, since numerous unrelated wingless Molytinae were infamous for their convergent similarity linked to the loss of hind wings (Lyal 2014). DNA-based search for relatives of the new genus was similarly inconclusive, since the dataset did not contain many critical and important taxa. Moreover, due limitations in funding, the DNA work was done with the single marker of the DNA barcode (part of cytochrome oxidase I, Hebert et al. 2003), which had significant limitations in its applicability for detecting relatively old evolutionary events (Grebennikov & Heiss 2014). Eventually, however, a representative of the genus *Leiosoma* became available for DNA analysis and consistently clustered with a clade representing the new genus. At that point the project's results were judged mature enough to be formally presented, even though some shortcomings linked to a shortage of the material and data remained (see Discussion).

Another coincidental event further triggering the completion of this project was the recent publication of the long-awaited "Phytophaga" volume of the Handbook of Zoology series, most specifically the chapter on the weevil subfamily Molytinae (Lyal 2014). This subfamily has long been and still is a phylogenetic challenge. In the aforementioned chapter the tribes of Molytinae were significantly reorganized, as compared to the earlier standard works of reference (Alonso-Zarazaga & Lyal 1999; Bouchard et al. 2011; Alonso-Zarazaga 2013). The most noticeable novelty, however, was the incorporation of the entire former "subfamily Cryptorhynchinae" into Molytinae, the latter presently containing 37 tribes plus ca. 28

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incertae sedis genera (Lyal 2014: 530, 531). This decision is in line with the pivotal work of Kuschel (1987) amalgamating a multitude of former "subfamilies" into a broadly defined Molytinae (then excluding "Cryptorhynchinae"). Both steps are seen as a much needed attempt to make the formal classification more in line with the current phylogenetic hypothesis (for example, see the remarkable mosaic of both former "subfamilies" in McKenna et al. 2009). Given an acute lack of the phylogenetic framework for the subfamily and for the great majority of its tribes, numerous further changes in Molytinae classifications will undoubtedly follow. To move forward, a practical approach was outlined (Lyal 2014: 549) as to "... propose initial hypotheses for monophyletic groups within the Molytinae and then analyze them with both molecular and morphological characters..." This paper presents an attempt to answer this call for actions on Molytinae subgroups and to shed light on a small subsection of this grand, if indeed monophyletic, radiation.

This work has three main goals. First, to name formally the newly discovered genus and its two species. Second, to utilize available mtDNA sequences to test the monophyly of the genus and to search for the possible sister group. Third, to discuss and delimit species boundaries and to undertake a dated phylogeographical analysis. Forth, to advance understanding of Molytinae genera currently attributed to the subtribes Molytina and Plinthina by providing an annotated list of taxa, illustrating a representative species for all but three genera and clarifying the identity of five obscure genera by re-examination of the type specimens of their type species. Overall, this paper continues the recently initiated efforts to assess phylogeographical patterns detected from the low-dispersing flightless weevils in southwestern China and adjacent lands and to clarify the taxonomy and diversity of wingless Old World Molytinae (Grebennikov 2014).

MATERIAL AND METHODS

Museum abbreviations, followed by the name of the curator:

BMNH Natural History Museum, London, UK (M. Barclay);
CMN Canadian Museum of Nature, Ottawa, Canada (R. Anderson, F. Genier);
CNC Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Canada (P. Bouchard);
IZCAS Institute of Zoology, Chinese Academy of Science, Beijing, P.R. China (R. Zhang);
MNHN Muséum national d'Histoire naturelle, Paris, France (H. Perrin);
MRAC Musée Royal de l'Afrique Centrale, Tervuren, Belgium (M. De Meyer);
MTD Senckenberg Naturhistorische Sammlungen, Dresden, Germany (K.-D. Klass, O. Jäger);
NHMB Naturhistorisches Museum, Basel, Switzerland (E. Sprecher);
NMW Naturhistorisches Museum, Wien, Austria (H. Schillhammer);
ZIN Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia (B.A. Korotyaev).

This study is based on examination of a total of 97 dry-mounted adult specimens of the new genus. Concepts of the Curculionoidea family-group names and assignment of weevil genera to tribes follow Bouchard et al. (2011) and Alonso-Zarazaga & Lyal (1999), respectively, with subsequent significant modifications by Lyal (2014). The chronostratigraphic timing is that of Cohen et al. (2013) with the Pliocene-Pleistocene boundary set at 2.588 MY. Nomenclature of male genitalia follows that of Wanat (2007). The length of the body was measured in dorsal aspect from the elytral apex to the front of the pronotum. Geographical labels of the newly described species are cited verbatim in quotation marks. The hypothetical most recent common ancestor of a monophyletic group referred to in the discussion is abbreviated as MRCA. The distribution map was generated using the online SimpleMappr tool (Shorthouse 2010). Species identification of the two sequenced specimens of *Leiosoma reitteri* (Bedel) was done based on the assumption that this is the only species of the genus known from Georgia (Alonso-Zarazaga 2013). The type species are cited using their presently valid names, which are not necesserely the same when the type species were designated; the latter can be found in Alonso-Zarazaga & Lyal (1999).

DNA dataset. All specimens submitted to DNA barcoding have a unique identifier label with the code CNC-COLVG0000XXXX; this format is shortened to #XXXX when specimens are cited in the text. All details regarding sequencing, primers, PCR protocols as well as the list of specimen information including provenience and voucher number can be seen by accessing the online dataset at: dx.doi.org/10.5883/DS-MORIMO90. In a few cases a specimen failed to amplify DNA from the first attempt and was later resubmitted; in such cases a digit "1" after a dot follows the original four digit number (like #0251.1 on Fig. 7). The dataset used for the first DNA analysis contained 90 sequences and 658 aligned positions. The ingroup was formed by 46 newly generated sequences, each representing a specimen of the continental new species of the new genus (GenBank accessions: HM417727–32, HQ986799, HQ986876–8, HQ987105,

HQ987134–5, HQ987159, HQ987179–81, KJ871620–32, KJ871634–5, KJ871637–40, KJ871642–51). All but one specimen representing another new species collected in Taiwan in 1992–1998 were submitted to DNA barcoding but failed to amplify, likely because of either their age, collecting methods or storage degraded DNA. No fresh specimens of the target genus were recovered in Taiwan during a month-long fieldwork in 2013. The majority of the ingroup sequences were 658 basepairs (bp) long and no one shorter than 407 bp. The outgroup consisted of 44 sequences and represented all Molytinae genera with available DNA barcode data (Fig. 7), while three sequences of *Graptus circassicus* Solari, 1945 (Entiminae) were used to root the topology in the first analysis (see below). All outgroup sequences were of the full DNA barcode length (658 bp). Three of the outgroup sequences representing the genus *Plinthus* Germar, 1817 (KJ871633, KJ871636, KJ871641) were newly generated. The remaining 41 outgroup sequences were taken from previous works (HM386450, HM417677–9, HQ986888–9, HQ987002–3, KJ427730–2, KJ427736–9, KJ427744, KJ427746, KJ427748, KJ445683–4, J445687, KJ445690–1, KJ445693–4, KJ445698–6, KJ445708–9, KJ445712–3, KJ445715 in Grebennikov 2014; KJ841729, KJ841731 in Grebennikov & Pham 2014). Specimen images (when present), geographical data, primers, original chromatograms and other relevant data for all 90 sequenced specimens can be found online in the publicly accessible dataset "*Morimotodes*" on the Barcode of Life Database portal (doi: dx.doi.org/10.5883/DS-MORIMO90).

DNA-based phylogenetic analyses. Two separate tree search analyses were run. The first analysis aimed at testing monophyly of the new genus represented by the type species, search for its sister-group and to examine its internal relationships. The original DNA dataset containing 90 sequences was analysed using the Maximum Likelihood (ML) approach with statistical branch support tested by 1000 replications of bootstrapping in MEGA 5 (Tamura et al. 2013). The search for the optimal substitution model for both analyses was done in MEGA 5 and resulted in the same model (GTR+G+I). The second tree search analysis was performed to date the branching events in the continental species of the new genus and to re-test the interrelationships hypothesis, as already suggested in the first analysis. The original matrix of 90 sequences was reduced to 33 to include only the full-length DNA barcodes (658 nt) of 31 ingroup specimens and two specimens of the sister group (the genus *Leiosoma*, as suggested in the first analysis). The second analysis was performed in BEAST v1.8.0 (Drummond et al. 2012) utilizing the Bayesian inference (BI) approach with no *a priori* internal grouping, all default priors and options, GRT+G+I nucleotide substitution model, strict linear molecular clock and nucleotide substitution rate of 0.018 (Papadopoulou et al. 2010). The "burn in" option was implemented eliminating the first 2500 of the 10000 obtained trees. Two resulting topologies, each representing either ML or BEAST analysis, were visualized in FigTree v1.4 (Rambaut 2013) and presented by Figs 7 and 8, respectively.

Use of morphological data. A formal morphology-based phylogentic analysis of Molytinae genera to search for the sister group of the new genus was beyond the scope of the present paper. Even restricted to 81 genera of the tribe of Molytini (80 mentioned in Lyal 2014, and the new one), the task was judged as too daunting. An attempt was made to illustrate a representative of all genera currently assigned to Molytina and Plinthina (13 and 17, respectively; see Lyal 2014: 530, 531; images of three genera were not obtainable). Five particularly poorly known genera were elucidated in more details, with their type specimens and original labels imaged. The third remaining Molytini subtribe, Hylobiina, historically considered as a tribe of its own and incorporating 51 winged genera (Lyal 2014) was not included in this treatment. This decision is partly due to the large size of this tribe. The second reason for exclusion is that until very recently, Hylobiina were formally in a separate tribe and, therefore, not specifically targeted since 2008, when this project was in preparation.

***Morimotodes* g. n.**

Type-species: *Morimotodes ismene* sp. n., by original designation.

Diagnosis. Adult specimens of *Morimotodes* g. n. can be immediately recognized from other Curculionoidea known both from the Eastern Palaearctic and the Oriental Region by their habitus. They are small (about 2 mm) brown or reddish beetles with lustrous dorsum, rounded body and nearly obliterated elytral shoulders and striae. In the area of their known distribution, namely in Yunnan, Sichuan and Taiwan, as well as in the adjacent regions, adults of *Morimotodes* externally resemble those of *Otibazo* Morimoto. The latter, however, has not yet been discovered in China (although its presence is possible, since the first continental species has been recently detected in northern Vietnam, see Grebennikov & Pham, 2014). Adults of *Otibazo* are immediately distinguishable from nearly all weevils by their unique fields of short dense pubescence forming characteristic whitish tufts on flagella, femora and tibiae (Fig. 7), not found in *Morimotodes*. Field recognition of *Morimotodes* can be facilitated by stressing their biological preferences. All known specimens have been found in wet leaf litter of primary deciduous forests in the altitudinal range of 1947–4072 m in southwestern China and 1110–2550 m in Taiwan. From the most closely re-

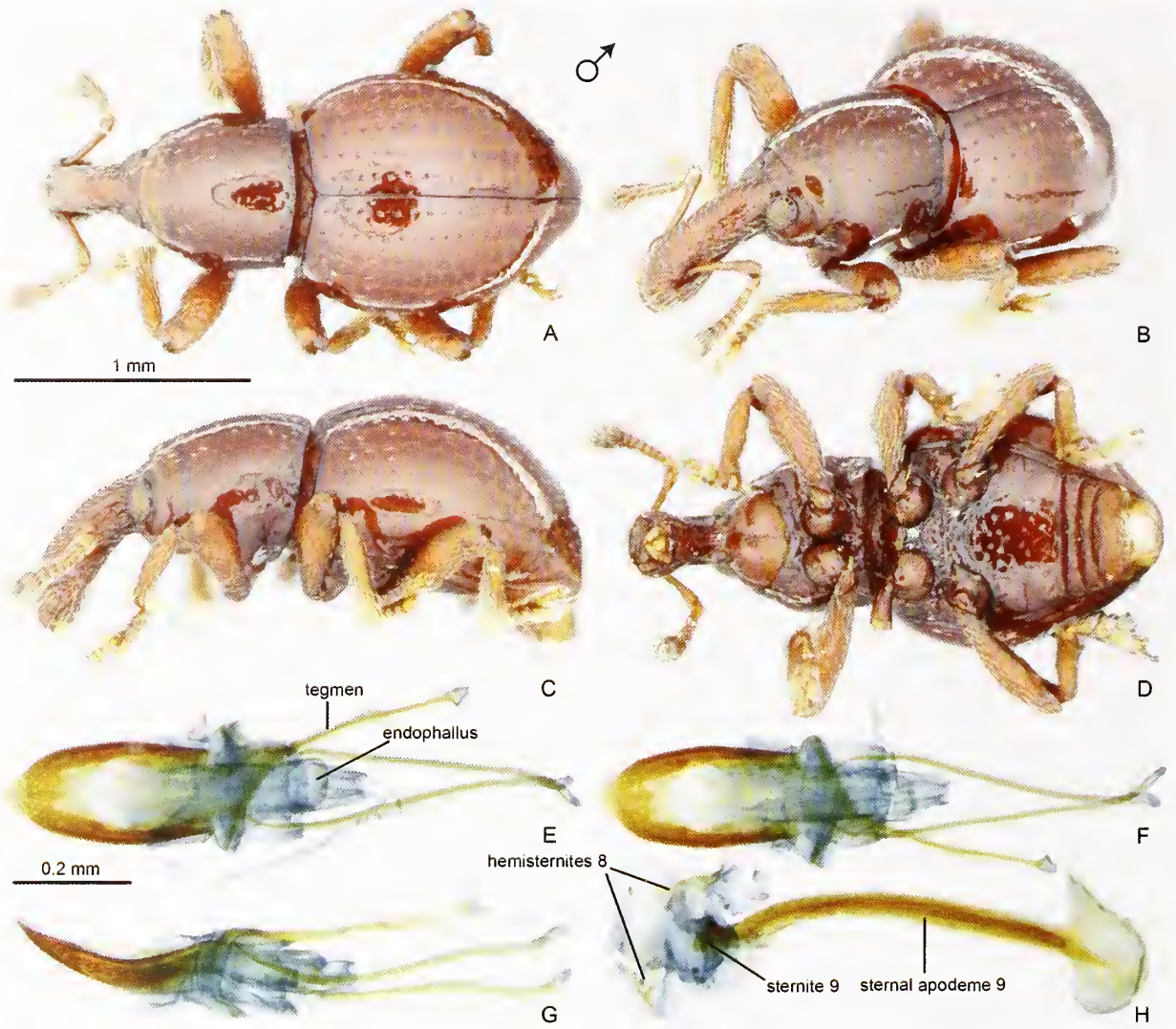

Fig. 1. *Morimotodes ismene* g. & sp. n., holotype, male, #0928 from Gaoligong Mt. Range, Yunnan. A–D: habitus; E–G: aedeagus and tegment, dorsal (E), ventral (F), lateral; (G); H: sternites 8 and 9.

lated genus *Leiosoma*, adults of *Morimotodes* g. n. ean be easily distinguished by their brown or reddish eolour (*Leiosoma* adults are black) and, additionally, by a wide gap in distribution (*Leiosoma* is restrieted to the West Palaearetie and, therefore, is widely allopatrie with *Morimotodes* g. n.).

Description. Small (1.6–2.1 mm) and uniformly brown or dark reddish, lustrous, wingless weevils. Dorsal surfaee of pronotum and elytra without longitudinal ridges, earinae or irregular seulpture; elytral striae weakly indieated by individual rows of fine setiferous punetures surrounded by elearly restrieted zone of darker pigmentation (Figs 1A–C, 6A–C); setiferous punetures on pronotum shallower, not arranged in longitudinal rows and laeking pigmented surroundings (Figs 1A–C, 6A–C). Length of dorsal setae variable, from almost indistinguishable under 50x magnifieation (Figs 6A–C, "polished" speeimens) to relatively long and exeeeding in length longitudinal distanee between setiferous punetures (Figs 4B, 5B, "hairy" speeimens). Integument elean, not eovered by inerustation or wax seeretion. Elytra with shoulders entirely levelled, in dorsal view strongly and evenly rounded, 1.5–1.8x as wide as maximal prothoraeie width. Body dorsal outline in lateral view evenly and relatively strongly eurved (Fig. 5); elytra neither flattened dorsally, nor deelivate apieally. Head eapsule moderately visible from above (Fig. 4). Eyes laterally, not redueed in size. Antennal attaehments in apieal third of rostrum; funiele with seven antennomeres; eompaet elub eonsisting of three antennomeres. Pronotum not eonstrieted laterally in anterior quarter; widest at middle or at base; prosternum without rostral eanal or oeular

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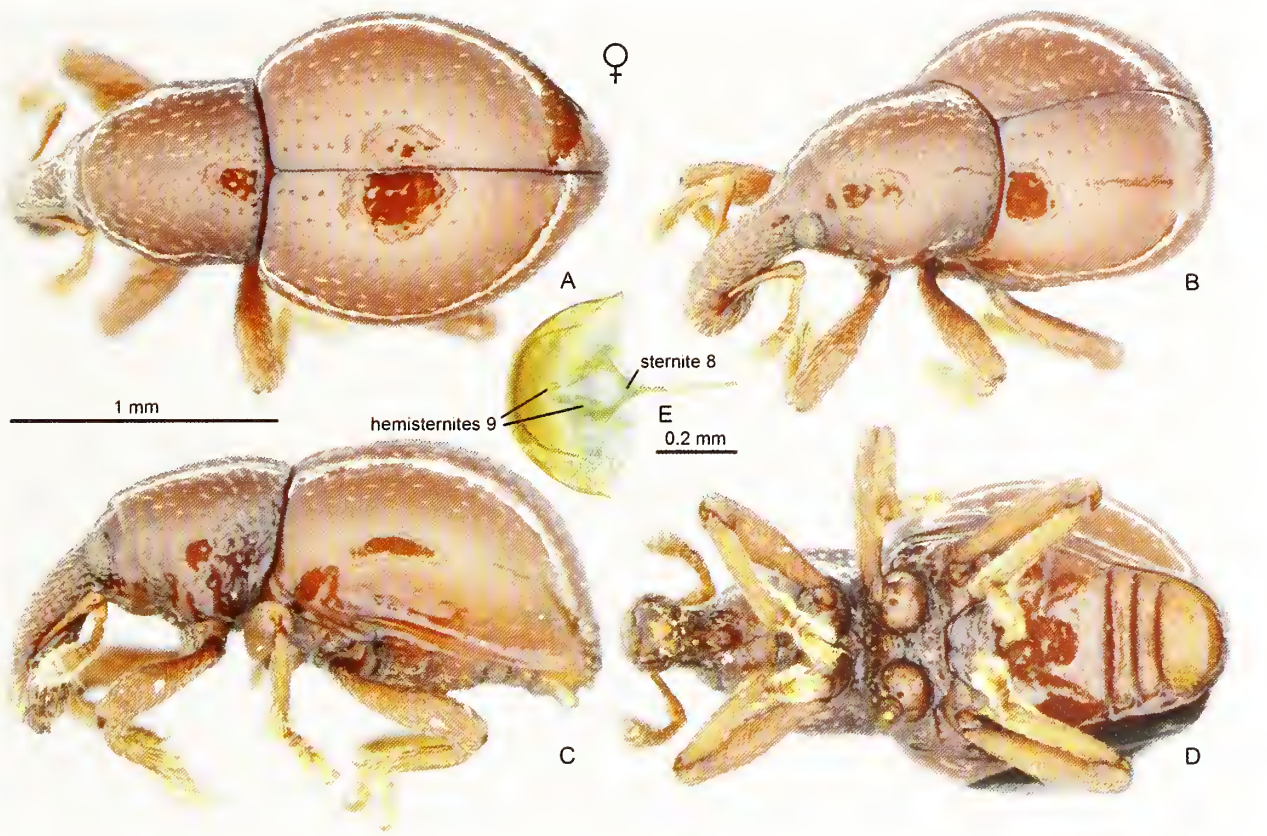

Fig. 2. *Morimotodes ismene* g. & sp. n., paratype, female, #1020 from Gaoligong Mt. Range, Yunnan. A–D: habitus, E: genital sternites 8 & 9, ventral view.

lobes; procoxae contiguous. All femora without tooth. Hind wings absent. Sclerolepidia absent (Fig. 3E). Aedeagus weakly sclerotized, dorsally and ventrally membranous and translucent; endophallus without slerotization (Figs 1E, F, 6E, F). Female hemisternites 9 each with separate and clearly distinguishable basal and apical pieces (Fig. 2E; "coxite" and "stylus", respectively).

Species composition and distribution. As currently known, the genus *Morimotodes* g. n. comprises two species, each relatively widely distributed in Southwest China (Yunnan and Sichuan) or in Taiwan, respectively.

Biology. All specimens of *Morimotodes* were collected by sifting deciduous leaf litter in montane primary forests with subsequent specimen extraction using Winkler funnels. These collecting circumstances were further corroborated by the loss of hind wings, which strongly suggest that *Morimotodes* species are habitat-dependant low-dispersing forest litter inhabitants critically dependant on this habitat. Immature stages, host plants or any specific biological preferences remain unknown.

Etymology. *Morimotodes*, patronymic, derived by adding the Latin suffix *-odes* to the family name of Katsura Morimoto (retired, formerly professor at Kyushu University, Fukuoka, Japan), in recognition of his outstanding contribution to the knowledge of weevils from the Asia-Pacific Region. Gender masculine.

***Morimotodes ismene* sp. n.**
Figs 1–5.

Diagnostic description. Holotype, male (Fig. 1). GenBank accession: HQ987135. Length: 1.85 mm. Dorsal outline of pronotum in lateral view evenly rounded; pronotum and elytra dorsally with fine punctures and white pilosity visible at magnification below 30x; each elytron with single longitudinal groove adjacent and parallel to edge. Aedeagus parallel-sided; sternite 9 not subdivided and not wider than 1.5x width of apodeme; sternal apodeme 9 with large paddle-shaped extension anteriorly. **Intraspecific variation.** Length: 1.60–2.0 mm. Body outline in dorsal and lateral views variable (Figs 4, 5), pronotum in basal half either parallel-sided (Fig. 4D) or

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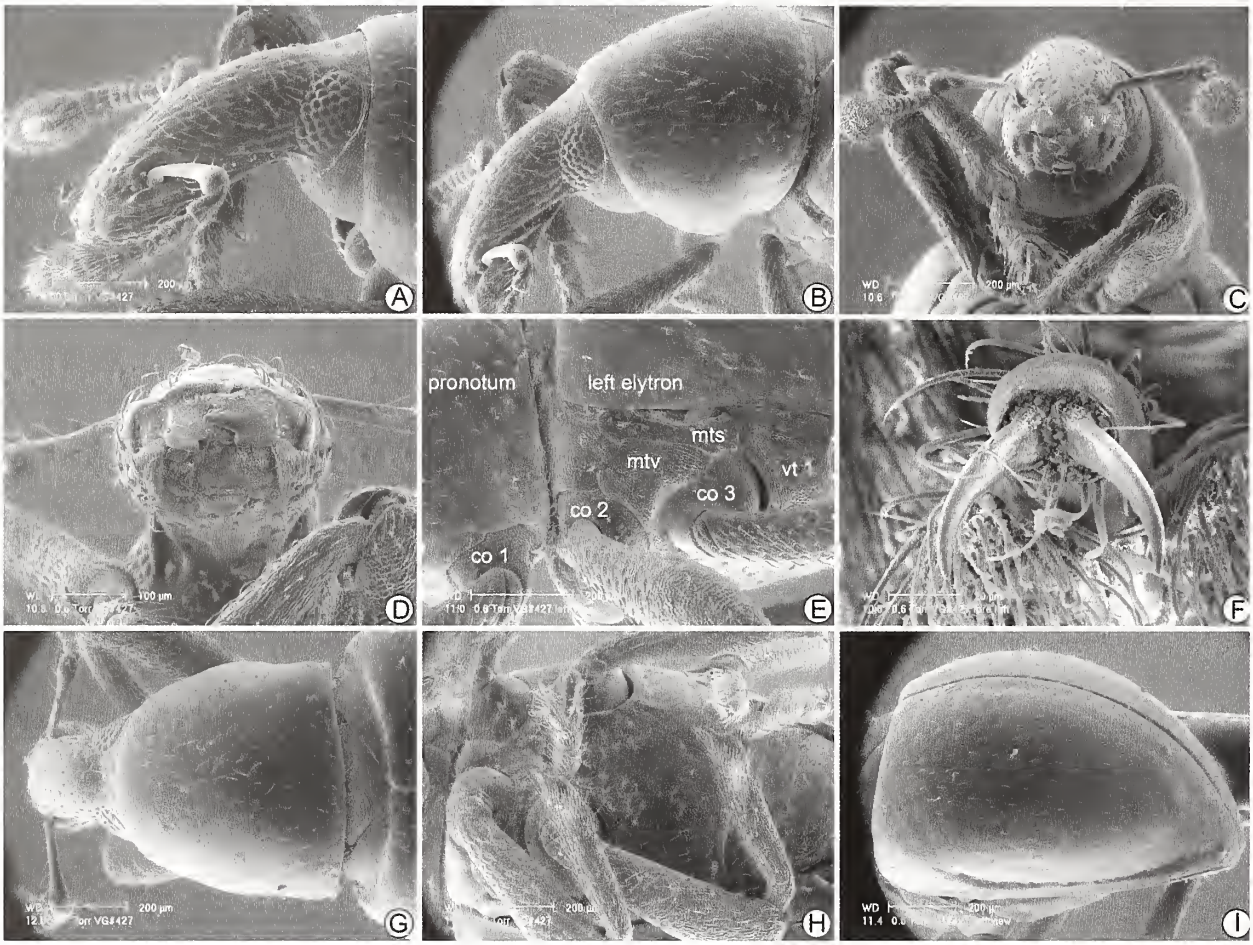

Fig. 3. *Morimotodes ismene* g. & sp. n., unsexed, #0427 from Cang Shan Mt. Range, Yunnan. SEM images. A: head, left lateral; B: head and pronotum, left lateral; C: head, frontal; D: rostrum, frontal; E: meso- and metathorax, left lateral; F: claws, lateral; G: pronotum and head, dorsal; H: meso- and metathorax, right ventro-lateral; I: elytra, left lateral. Mst: metepisternum, mtv: metaventrite, co1–co3: pro-, meso- and metaxocae, respectively, vt1: ventrite 1 (=abdominal segment 3). Note absence of sclerolepidia on metepisternal suture separating metepisternum and metaventrite; the presence of this suture in apterous weevils is unusual.

weakly broadened posterad (Fig. 4E); dorsal outline of rostrum-to-head junction even (Fig. 5B), evenly and weakly depressed (Figs 1A, 5A) or marked more abruptly (Fig. 5D). Dorsal body puncture and pilosity variable, from mostly faint (Fig. 5D) to markedly developed (Fig. 5B).

Material examined. Holotype male (IZCAS): #0928, "P.R. CHINA, Yunnan, E slope N Gaoligongshan, N27°47'22.1 E098°32'17.7, 24.v.2010, 3027m, sifting20, V.Grebennikov". **Paratypes** (CNC, IZCAS, MTD), 19 in total: 4 exx, #0114–6, #0503: "P.R. CHINA, Yunnan, E slope N Gaoligongshan, N27°46.212' E098°36.221', 12.vi.2009, 2312m, sifting02, V.Grebennikov"; 5 exx, #0144 and 4 not numbered: "P.R. CHINA, Yunnan, E slope N Gaoligongshan, N27°46.782' E098°33.087', 14.vi.2009, 2956m, sifting04, V.Grebennikov"; 2 exx, not numbered: "P.R. CHINA, Yunnan, E slope N Gaoligongshan, N27°46.665' E098°33.321', 15.vi.2009, 2982m, sifting05, V.Grebennikov"; 1 ex, not numbered: "P.R. CHINA, Yunnan, E slope N Gaoligongshan, N27°46.635' E098°33.381', 16.vi.2009, 2946m, sifting07, V.Grebennikov"; 2 exx, #0927 and 1 not numbered: same data as holotype; 1 ex, #0977: 2010/21 "P.R. CHINA, Yunnan, E slope N Gaoligongshan, N27°47'22.1 E098°32'17.7, 24.v.2010, 3027m, sifting21, V.Grebennikov"; 4 exx, #1017–20: "P.R. CHINA, Yunnan, E slope N Gaoligongshan, N27°59'01.0 E098°32'56.9, 27.v.2010, 3018m, sifting22, V.Grebennikov".

Additional non-type specimens: Cang Shan Mt. Range (15 in total, CNC): 14 exx, #0300–1, #0427, #0499–502, 7 not numbered: "P.R.CHINA, Yunnan, Cangshan, N25°40.381' E100°08.016', 30.v.2008, 2600m, sifting, V.Grebennikov"; 1 ex, #0867: "P.R. CHINA, Yunnan, E

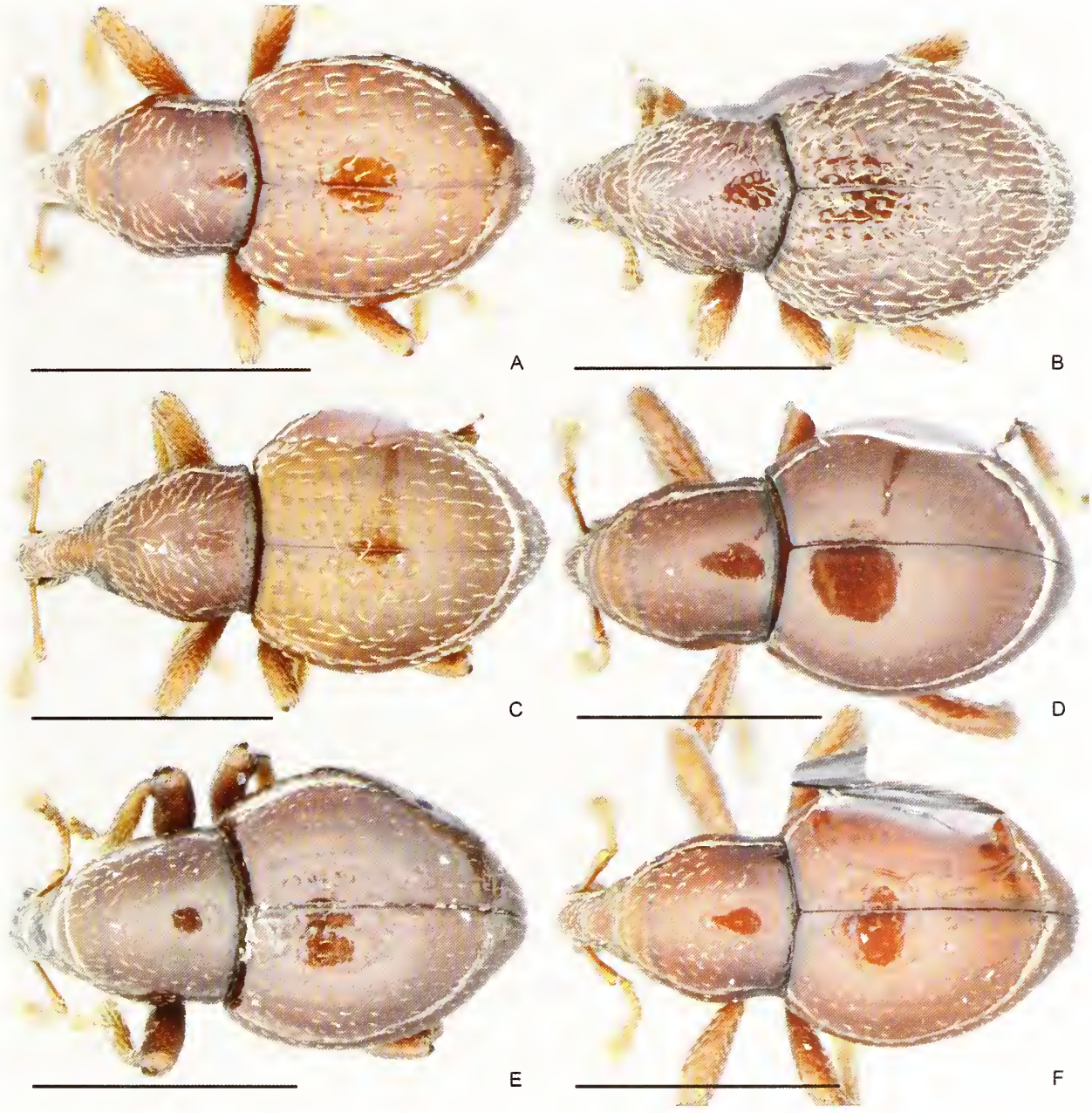

Fig. 4. *Morimotodes ismene* g. & sp. n., unsexed, dorsal view. A: #2409 from Mount Gongga, Sichuan; B: #4483 from Mount Haba, Yunnan; C: #6185 from Mount Emei, Sichuan; D: #1105 from Mount Emei, Sichuan; E: #0867 from Cang Shan Mt. Range, Yunnan; F: #0251 from Mount Emei, Sichuan. Scale: 1 mm.

slope Cangshan at Dali, N25°40'15.5 E100°07'45.4, 18.v.2010, 2657m, sifting17, V.Grebennikov". Mount Haba (6 in total, CNC): 4 exx, #4481–4: "CHINA, Yunnan, Haba Shan, N27°21'01" E100°05'44", 21.vi.2012, 4072m, sift26, V. Grebennikov"; 2 exx, #4536–7: "CHINA, Yunnan, Haba Shan, N27°21'01" E100°05'44", 28.vi.2012, 4072m, sift35, V. Grebennikov". Mount Gongga (9 in total, CNC): 1 ex, #2409: "P.R. CHINA, Sichuan, NE slope Gongga Shan, N29°48'15" E102°03'44", 06.vi.2011, 2765m, sift11, V.Grebennikov; 1 ex, #2456: "P.R. CHINA, Sichuan, NE slope Gongga Shan, N29°50'50" E102°02'28", 09.vi.2011, 3170m, sift14, V.Grebennikov"; 3 exx, #2471–3: "P.R. CHINA, Sichuan, NE slope Gongga Shan, N29°50'05" E102°02'53", 11.vi.2011, 3019m, sift15, V.Grebennikov"; 2 exx, #2559–60: "P.R. CHINA, Sichuan, NE slope Gongga Shan, N29°49'33" E102°03'06", 21.vi.2011, 2977m, sift24, V.Grebennikov"; 3 exx, #2562–3: "P.R. CHINA,

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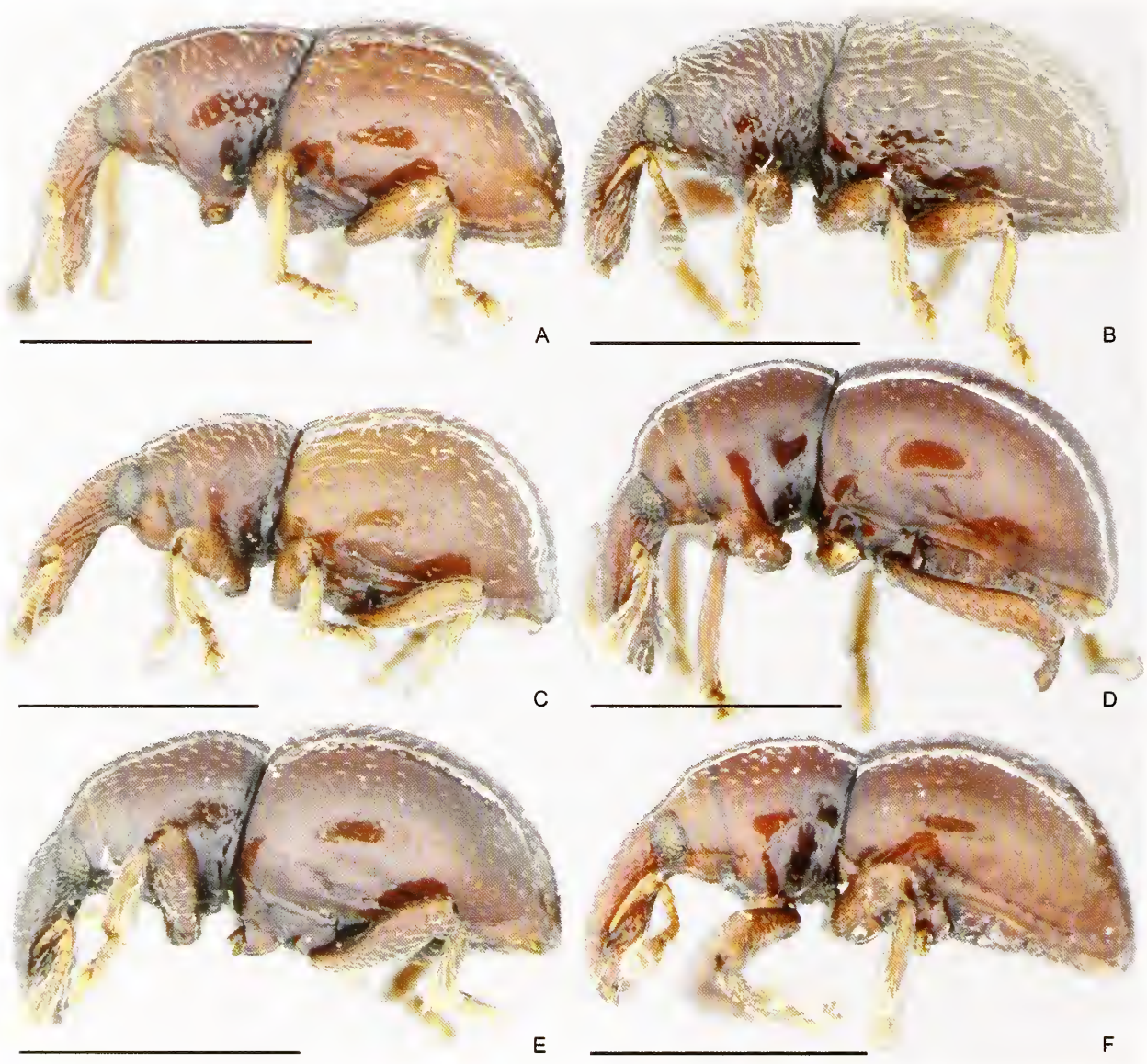

Fig. 5. *Morimotodes ismene* g. & sp. n., unsexed, left lateral view. A: #2409 from Mount Gongga, Sichuan; B: #4483 from Mount Haba, Yunnan; C: #6185 from Mount Emei, Sichuan; D: #1105 from Mount Emei, Sichuan; E: #0867 from Cang Shan Mt. Range, Yunnan; F: #0251 from Mount Emei, Sichuan. Scale: 1 mm.

Siehuan, NE slope Gongga Shan, N29°49'29" E102°03'24", 21.vi.2011, 2986m, sift25, V.Grebennikov". Mount Emei, elade EM-A (10 in total, CNC): 10 exx, #1216–9: #6184–9: "P.R. CHINA, Siehuan, EmeiShan, N29°32'37.3 E103°19'57.5, 18.vi.2010, 2440m, sifting37, V.Grebennikov"; elade EM-B (6 in total, CNC): 4 exx, #0251–3, #0504: "P.R. CHINA, Sichuan, Emei Shan, N29°32.932' E103°20.466', 01.vii.2009, 2310m, sifting14, V.Grebennikov"; 1 ex, #0505: "P.R. CHINA, Siehuan, Emei Shan, N29°32.806' E103°20.106', 03.vii.2009, 2342m, sifting15, V.Grebennikov"; 1 ex, #1172 and #4186 (two numbers on the same speeimen): "P.R. CHINA, Siehuan, EmeiShan, N29°32'37.3 E103°19'57.5, 18.vi.2010, 2440m, sifting37, V.Grebennikov"; elade EM-C (1 in total, CNC): 1 ex, #1105: "P.R. CHINA, Siehuan, EmeiShan, N29°33'36.3 E103°20'38.0, 15.vi.2010, 1947m, sifting33, V.Grebennikov".

Distribution. The speeies is known from five isolated high altitude forest regions in Yunnan and Siehuan provinees (Fig. 9).

Etymology. The speeies epithet is the Latinized Greek mythieal name of Ismene, a daughter and half-sister of Oedipus, daughter and granddaughter of Joeasta, and sister of Polyniees; noun in apposition.

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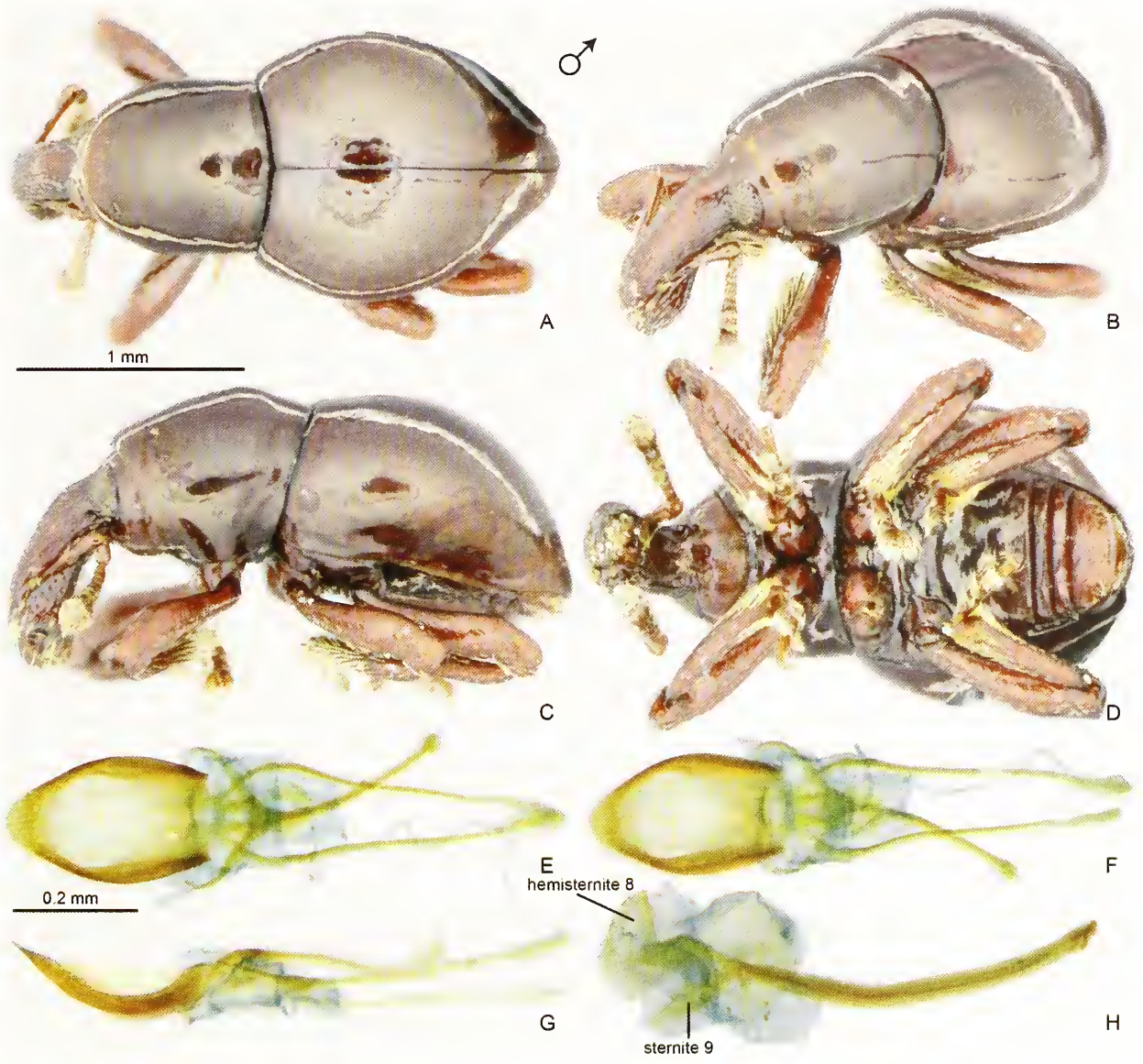

Fig. 6. *Morimotodes polynices* g. & sp. n., holotype, male, #5949 from Taiwan. A–D: habitus; E–G: aedeagus and tegment, dorsal (E), ventral (F), lateral; (G); H: sternites 8 and 9.

***Morimotodes polynices* sp. n.**
Fig. 4.

Diagnostic description. Holotype, male (Fig. 6). DNA not sequenced. Length: 2.00 mm. Dorsal outline of pronotum in lateral view with hump in basal third; pronotum and elytra dorsally with fine punctures and pilosity not visible at magnification below 30x; each elytron without longitudinal groove parallel to edge. Aedeagus rounded laterally, sternite 9 Y-shaped and about 3–5x wider than apodeme; sternal apodeme 9 without extention anteriorly. **Intraspecific variation.** Length: 1.98–2.12 mm.

Material examined. Holotype male (CMN): #5949 "TAIWAN, Kaohsiung Hs. Rd. Abv. Tona For. Sta. Km16–17, 1700–1800m 28.V.1998, A.Smetana (T190)". **Paratypes** (CNC, CMN), 26 in total: 2 exx, #5925–6: "TAIWAN, Kaohsiung Hsien, Kuanshan trail at Kaunshanchi Riv. 2400 m 24.VI.1992 A. Smetana (T94)"; 9 exx, #5927–35: "TAIWAN, Kaohsiung Hsien, Peinantashan trail, 2000m 7.VII.93 A. Smetana (T144)"; 1 ex, #0587: "TAIWAN, Kaohsiung Hsien, Kuanshan trail above Kaunshanchi Riv., 2550m, 22.VII.93 A. Smetana (T160)"; 1 ex, #5936: "TAIWAN, Kaohsiung Hsien, Peinantashan trail 2450m, 2.V.1995 A. Smetana (T170)"; 13 exx, #5940–8, #5950–3:

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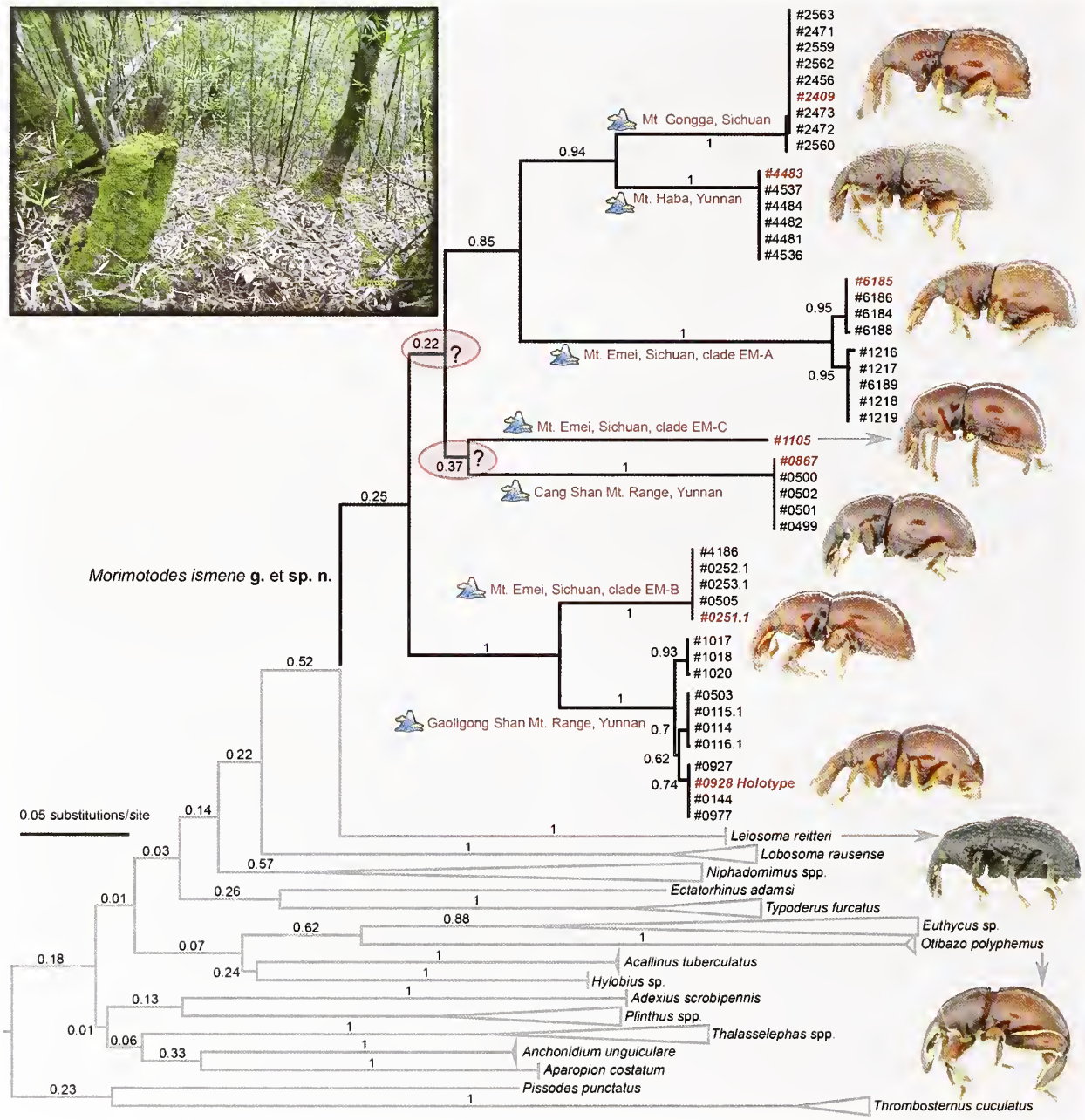

Fig. 7. Maximum Likelihood inference phylogram positioning monophyletic *Morimotodes ismene* g. & sp. n. (in black) as a sister to *Leiosoma reitteri* among other analysed Molytinae genera (in grey) using the 658 nt of the mtDNA barcoding CO1 gene fragment. Digits at internodes are bootstrap values. The tree is rooted on *Graptus circassicus* (Entiminae; not shown). Seven geographically linked lineages of *M. ismene* g. & sp. n. are marked in red; note that Mount Emei uniquely harbours three unrelated lineages. Red and italicized numbers are those of imaged specimens (Figs 1, 4, 5) illustrating respective clades. Two pink ovals with question marks denote two nodes not recovered in the alternative BI analysis (Fig. 8). Inserted image of the forest illustrates exact spot where the type specimen #0928 was found.

same data as holotype. **Additional non-type specimens:** 3 exx, (CMN), #5937–9: "TAIWAN, Ilan Hsien Shen-Mi Lake 24°22'43"N 121°44'12"E, 1110m 10.V.1995 A. Smetana (T177)".

Distribution. The species is known from two widely separated regions in southern and northern Taiwan, respectively (Fig. 9).

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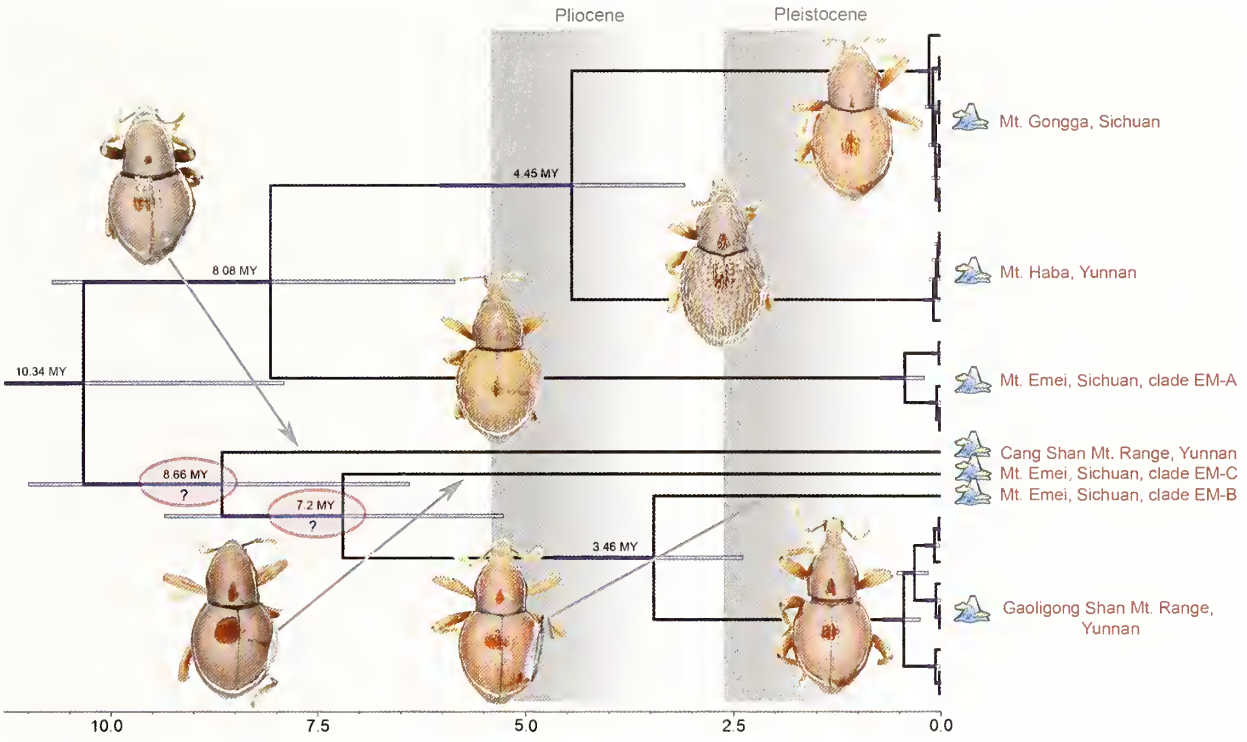

Fig. 8. Ultrametic tree of *Morimotodes ismene* g. & sp. n. reconstructed using Baeysian inference method strict linear molecular clock approach to analyse 658 nt of the mtDNA barcoding CO1 gene fragment and calibrated at a rate of 0.018 substitutions/site/MY. Numbers at nodes and on the scale below are million years before present. Node bars represent 95% confidence intervals of the age estimate. Two pink ovals with question marks denote two nodes not recovered in the alternative ML analysis (Fig. 7).

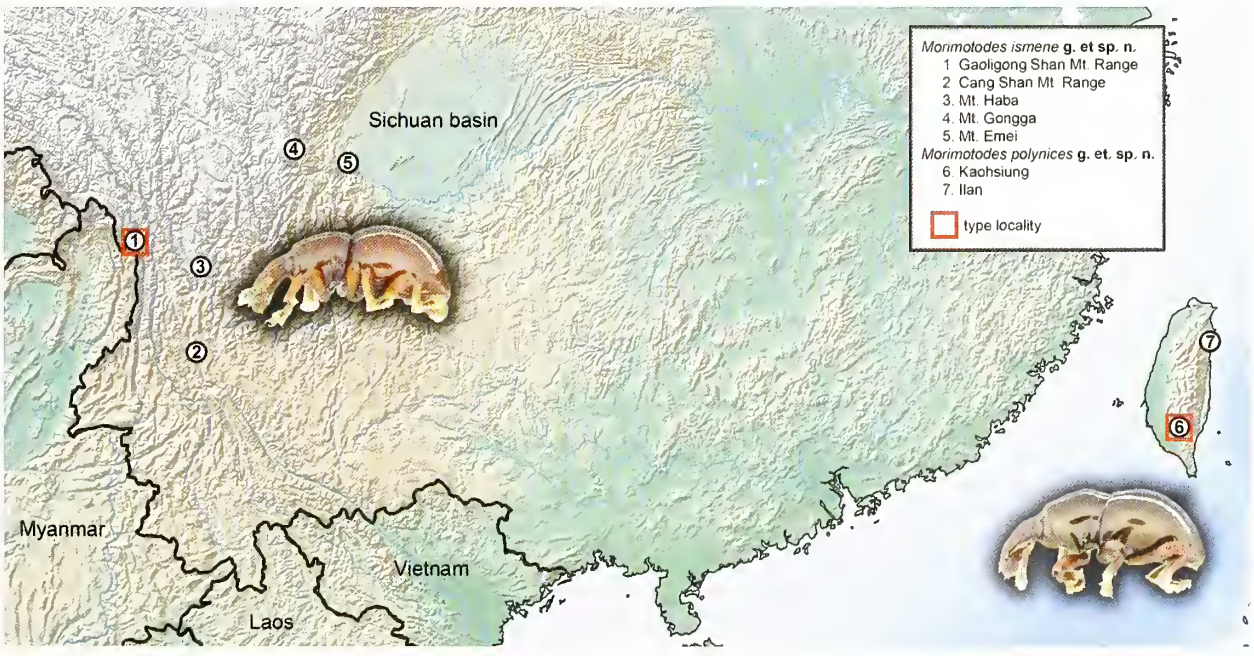

Fig. 9. Known distribution of *Morimotodes* g. n.

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Etymology. The species epithet is the Latinized Greek mythical name of Polynices, the son of Oedipus and Jocasta, as well as a grandson of Jocasta; noun in apposition.

RESULTS

The first tree seareh resulted in a Maximum Likelihood tree (Fig. 7) with the highest log likelihood of – 9190.09. All analyzed speeimens of *M. ismene* g. & sp. n. formed a weakly supported clade (bootstrap value 25%). The genus *Morimotodes* g. n., represented by only its type-species, formed a moderately supported (52%) clade with the genus *Leiosoma*. Forty-six analyzed specimens of *M. ismene* sp. n. from five mountain regions formed seven geographical lineages (one monotypical, six others supported with 100% bootstrap). Four of these lineages corresponded to four mountain regions (Fig. 7), while all 15 analyzed specimens from Mount Emei formed three groups not most closely related to each other. Temporal (second) analysis in BEAST (Fig. 8) recovered all *Morimotodes* specimens forming a clade with the same seven lineages as in the first analysis, although the grouping among themselves was not identieal with the results of the first analysis. The inferred timing of the splits forming the seven geographically linked lineages within monophyletic *M. ismene* g. & sp. n. detected in the second analysis date between 10.34 MY to 3.46 MY (Fig. 8).

DISCUSSION

Monophyly and sister group of *Morimotodes* g. n.

As presently defined, the genus *Morimotodes* g. n. is most likely monophyletic. This assertion is not tested by the cladistic methods, and is based entirely on circumstantial evidence. None of the 29 specimens of *M. polynices* g. & sp. n. responded positively to a DNA amplification effort and, therefore, the speeies was not represented in the DNA analyses. Continental populations of *Morimotodes* g. n. from Yunnan and Sichuan all assigned to a broadly defined *M. ismene* g. & sp. n. were consistently recovered as a monophyletic clade in the first tree analysis (Fig. 7). The assumption of both *Morimotodes* g. n. species forming a clade is based entirely on their adult external similarities, further corroborated by the analogous collecting circumstances suggesting similar biology. The geographical gap of about 2000 km separating known distributional arcas of both speeies is not large enough to shed significant doubts on their sister group relationships. Sueh are all presently available data to justify the implemented taxonomic decisions of grouping both species into a presumably monophyletic new genus.

The most surprising aspeet of the first analysis is the relatively weak statistical support for *M. ismene* g. & sp. n. (25%, Fig.7), which can be at least partly attributed to the known phylogenetic limitations of CO1 (Maddison 2012), including the saturation effect.

The sister-group relationships between *Morimotodes* g. n. and the West Palaearctic *Leiosoma* is moderately supported (bootstrap 52% (Fig. 7). Close affinities of both genera have been hypothesised ever since the first representatives of *Morimotodes* g. n. came to notice in 2008, and was grounded entirely on adult morphological similarities (small weevils less than 3 mm in body length with laterally rounded and not flattened bodies and with shiny dorsum) and biological preferences (inhabitants of the deciduous leaf litter). Analogous expectations for the similarly shaped genus *Otibazo* were, however, rejected by the ML tree, the latter clustered with the genus *Euthycus* (Fig. 7). At present, it is impossible to suggest phylogenetic affinities of the clade *Morimotodes* g. n. + *Leiosoma*, since the available data are highly inadequate. Pending further investigation, the genus *Morimotodes* g. n. is placed in the same higher taxonomic group containing its sister group Molytinae: Molytini: Molytina.

If *Morimotodes* g. n. is indeed sister to *Leiosoma*, then attribution of both new species from China to the former genus eould be a phylogenetically sound taxonomic alternative. It was, however, rejected because establishing a new genus better reflects the significant external dissimilarity between their members and the wide gap in their known geographical distribution.

Species delimitation of *Morimotodes* g. n.

Both species of *Morimotodes* g. n. as presently defined are much dissimilar to eaeh other. The species from Taiwan, *M. polynices* sp. n., is known from a museum series of externally remarkably similar specimens, all but three of which were sampled from a geographically confined region (Kaohsiung, Fig. 9) not more than 50 km in its greatest detention and within the limited altitudinal range (1700–2550 m). This evidence suggests that all type specimens most likely share the MRCA. Three additional non-type specimens from north of Taiwan (Ilan, Fig. 9) are externally most similar to those from the type locality and, therefore, are thought to be conspeeific, although with lesser certainty. These two hypotheses could not be tested using DNA data, since the sequences were not obtainable. Judging from the morphological and geographical data, it seems unlikely that the Taiwanese specimens of *Morimotodes* g. n. could be grouped within the clade formed by their continental counterparts. This evidence, although not tested phylogenetieally, strongly suggests separate evolutionary history for the Taiwanese lineage worthy, therefore, of establishing a formal species.

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Deciding what to all a species for the continental members of *Morimotodes* g. n. is ambiguous. The most inclusive and conservative approach is, therefore, employed. All specimens of *Morimotodes* g. n. from continental China are presently assigned to the broadly defined *M. ismene* sp. n. This uncertainty on species boundaries is not made any easier by the relatively large amount of available relevant data for the continental species. The implemented decision to assign all continental *Morimotodes* g. n. to a single species is a balanced temporary solution implemented to minimize the conflict among four independent lines of evidence (in the increasing order of their contribution): (1) biological characteristics, (2) morphological similarity/dissimilarity (3) geographical distribution, and (4) mtDNA sequences. The logic of their combined evaluation is described below.

The condition determining the gene flow among *Morimotodes* g. n. populations inhabiting five continental localities (the Cang Shan and the Gaoligong Mountain Ranges, as well as Mounts Haba, Gongga and Emei; Fig. 9) can be considered analogous to those acting for terrestrial organisms confined to oceanic islands. This approximation is commonly used for the low-dispersing and flightless moisture- and habitat-dependent species found in relatively wet isolated forests widely separated by seemingly unsuitable lowlands. Such estimate might perhaps be even an understatement of the dispersal difficulties for the mountain species, since the salt water barriers are occasionally crossed by seemingly most unseaworthy organisms such as chameleons possibly rafting on dislodged floating trees, or blind subterranean Arthropods perhaps surviving the passage in soil attached to their roots (Raxworthy et al. 2002 and Peck 1990, respectively). The very first task with such allopatric mountainous low-dispersing organisms as *Morimotodes* g. n. was, therefore, to assess whether the specimens from each separate locality form distinct evolutionary clusters and whether any of the localities supports more than one such cluster.

The four aforementioned lines of evidence contributed conflicting data. Biological data were the least informative, since all sampled specimens of *M. ismene* sp. n. were sifted from seemingly similar forest litter and within comparable altitude range. The only exception was shown by the Mount Haba specimens recovered from the upper forest zone at altitude notably higher than known for other continental populations. Adult external morphology was the second least informative line of evidence (see below on the use of genital characters). Although the imaged specimens representing each of seven clades were somewhat dissimilar to each other (note the hairy specimen #4484 from Mount Haba, or the large and non-hairy specimen #1105 representing the clade EM-C from Mount Emei; Figs 4, 5), it was impossible to consistently distinguish the others. The most powerful signal came from the mtDNA sequences, which grouped specimens from four localities into four strongly supported corresponding clades (Fig. 7). The exception was Mount Emei, where 14 specimens clustered in two unrelated groups (EM-A and EM-B on Fig. 7) with an additional third equally unrelated lineage (EM-C) represented by a single specimen #1105. The emerging distributional pattern indicated that each locality supports at least one lineage of *Morimotodes* g. n., while Mount Emei has at least three such lineages. The main operational problem was that the majority of the seven detected radiations could neither be uniquely characterized morphologically, nor biologically.

It should be noted that detecting seven evolutionary separate lineages of continental *Morimotodes* g. n. inhabiting five discrete mountain regions is not prohibitive in itself. There are no reasons to expect that no more than a single radiation of closely related low-dispersing organisms should exist in any suitable locality. Among all five continental localities, Mount Emei should be rightfully expected to be the most diverse in *Morimotodes* g. n., because it is overwhelmingly rich in other forms of life and by that exceeds many other comparable localities. For example, its relatively well documented flora condensed on just 154 km^2 and lacking the entire alpine zone, encompasses an astonishing 3703 species of higher plants (Wang et al. 2013). This diversity exceeds Canada (3,156; Mosquin et al. 1995) and is comparable with that of the British Isles (3842, Fitter & Peat 2014). Summing up, the phylogeographic pattern as represented on Fig. 7 did not pose significant biological inconsistencies. By far the major challenge was the necessity to implement the Linnaean taxonomy and decide on how many nominal species are there.

At this stage the purely practical limitations of available material has to be mentioned. Mostly, specimens of *Morimotodes* g. n. are relatively rarely encountered. For example, the radiation inhabiting the Cang Shan Mountain Range responded well to the original sifting in 2008, however, DNA sequencing of the 2008 specimens resulted in only short fragments of 407 bp (four specimens #0499–0502). During the subsequent two visits to Cang Shan in 2010 and 2012, a significant greater sampling effort resulted in the collection of only a single specimen (#0867), but provided a full-length DNA barcode. Mount Emei has also been visited three times with one month of intense fieldwork in total. Among the 27 sifting samples, only five contained representatives of *Morimotodes* g. n. Four focussed samples were taken in two years within 50 meters from where the unique specimen #1105 (lineage EM-C, Fig. 7) had been sifted, but I failed to discover additional specimens. The entire lineage EM-A was recovered from a single sample. Only the lineage EM-B was detected in three samples, two of them taken in exactly the same place in different years and the third one some 650 m away. Such sampling results strongly suggest that specimens of the continental *Morimotodes* g. n. are most

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unevenly distributed in time and across seemingly identical landscape of mountainous forest.

Species delimitation in insects often relies on the shape of male genitalia. However, due to the scarcity of *Morimotodes* g. n. specimens coupled with possible structural damages during dissection of the minute genitalia, I refrained to examine genitalia of all sequenced specimens. It was impossible to sex specimens externally and, therefore, male genitalia dissection had to be attempted with a randomly chosen specimen, some of them females. Even more problematic were the difficulties linked to the mechanical body properties of these highly compact minute beetles with globular elytra firmly fused to the hind body and forming together a most robust, inflexible and, accordingly, highly breakable capsule. After the muscle tissue was nearly completely dissolved and the remaining internal structures much loosened, the genitalia were successfully dissected for the two holotypes, only. It was, therefore, judged inadvisable to perform extensive male genitalia dissections.

The practical conclusion reached after considering all was to define preliminarily a single species for all continental representatives of *Morimotodes* g. n., even though this taxon might be later split into more separate species. The Haba Shan lineage having distinct external adult morphology further corroborated by the unique biological preferences of higher altitudes can perhaps merit its own species even at present. This action, however, will render the rest of the continental *Morimotodes* g. n. paraphyletic and, therefore, is not implemented. Considering a likelihood of further taxonomic changes in the broadly defined *M. ismene* sp. n., the type series is purposely restricted to the specimens forming a separate lineage uniquely characterised by DNA and geographical data. Specimens from the Gaoligong Mountain Range forming the extreme west of the known generic distribution (Fig. 9) were chosen for this purpose, specifically because they are numerous in the DNA analysis. Additionally, this lineage is represented by specimens recovered in at least six separate samples taken from the area measuring 25 km in its greatest dimension and, therefore, having the least chances of harbouring an undetected sympatric congeneric lineage (i.e., like Mount Emei with at least three such lineages). Consequently, all specimens of *M. ismene* sp. n. from localities other than the Gaoligong Mountain Range are not designated as paratypes.

Dated phylogeography of *Morimotodes ismene* g. & sp. n.

Little can be presently said about the temporal aspect of *Morimotodes* g. n. evolution. The single and seemingly most interesting aspect of it, namely the time of the implied separation between continental *M. ismene* sp. n. and *M. polynices* sp. n. from Taiwan cannot be addressed at present because of the lack of mtDNA data to represent the latter species. Even though all seven lineages constituting monophyletic *M. ismene* sp. n. were consistently recovered in the first (ML) and the second (BI) analyses, their grouping was consistent in only three nodes (Fig. 8): (a.) the split between lineages inhabiting Mount Haba and Mount Gongga, (b.) their MCRA separating from the lineage EM-A inhabiting Mount Emei and (c.) the split between Mount Emei clade EM-B and the lineage from the Gaoligong Mt. Range. All four consistently recovered evolutionary events (three aforementioned and the origin of the entire *M. ismene* sp. n.) date 4.45 MY, 8.08 MY, 3.46 MY and 10.34 MY, respectively. These estimations provide a very approximate time frame for the origin and diversification of the continental *Morimotodes* g. n., which is comparable to those of the sympartically distributed weevil genera *Niphadomimus* Zherikhin, 1987 (Grebennikov 2014) and *Notaris* Germar, 1817 (Grebennikov & Kolov, unpublished) likely linked to the advanced stages of the uplift of the Tibetan Plateau (Favre et al. 2014).

Illustrated overview of genera of the subtribes Molytina and Plinthina

The catalog of Alonso-Zarazaga & Lyal (1999, 2002) had all genera currently assigned to Molytina and Plinthina already listed as such (except for two proposed later) and all included in the broadly defined Molytini. Since then the following changes were proposed: (1) the monotypic *Stenanchonus* Voss, formerly of Anchonini, was synonymized with *Enthycus* Pascoe of Molytina (Meregalli 2003); (2) some species of the genus *Minyops* Schoenherr of Plinthina was assigned to the newly erected *Paraminyops* Osella & Bellò (Osella & Bellò 2010); (3) the tribe Sthereini was re-erected to incorporate nine genera, four of them formerly of Plinthina (Alonso-Zarazaga 2013; Lyal 2014); (4) the former Molytini subtribe Typoderini was elevated to tribe level; (5) the former Molytini subtribe Leiosomatina was synonymized with Molytina (Lyal 2014); (6) the former tribe Hylobiini was synonymized with Molytini by forming its third and the last subtribe (Lyal 2014); (7) one new genus, *Morimotodes* g. n., being described herein. Moreover, the Palaearctic representatives of both subtribes accounting for about 80% of their species were recently catalogued (Alonso-Zarazaga 2013).

All 30 genera presently assigned to both subtribes are listed below and 27 of them are illustrated. This summary was done with the intention to bring them to the notice of the contemporary scientific community and hopefully trigger their reinvestigation in a phylogenetic framework using modern data and analytical methods. Up to now very little of such work has been done for the entire subfamily Molytinae, including both Molytina and Plinthina. Most importantly, reciprocal monophyly of both sub-

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tribes has never been demonstrated and, therefore, their taxonomic existence as currently defined seems very precarious yet. Moreover, with the exception of Craw's (1999) detailed analysis of the New Zealand's *Hadramphus* & *Lyperobius*, none of the non-monotypical genera shown in detail below has ever been tested for its monophyly. Some phylogenetically relevant statements were, however, made: Meregalli (1985) suggested a sister-group relation between *Minyops* (then containing *Paraminyops*) and *Plinthus*. Davidian (2008) proposed that the lineage presently consisting of *Paraminyops* and *Minyops* is most closely related to a subgroup of the genus *Plinthus* (rendering the former paraphyletic) and that *Hoplopteridius* forms a clade with all of them. Osella & Bellò (2010), when separating their new genus *Paraminyops* from *Minyops*, suggested that both genera together with *Hoplopteridius* form a group ("subtribe Minyopina", a synonym of Plinthina, Bouchard et al. 2011). None of these hypotheses have been analytically tested.

Subtribe Molytina

The tribe includes 13 genera, which are numbered and listed alphabetically below. Nine of them, as noted by Lyal (2014), are widely scattered from New Zealand and Australia, through New Guinea, Borneo, Java, and Indochina, to Sri Lanka, eastern India, China and Japan. Three other genera (*Anisorhynchus*, *Leiosoma* and *Liparus*) are distributed in the Western Palaearctic, with the former also known from Central Asia (Alonso-Zarazaga & Lyal 1999). One genus known only from the holotype (*Pterotomus*) is restricted to Angola.

***Anisorhynchus* Schoenherr, 1842** (Figs 10A, B). This is a genus of 13 large-bodied species and one non-nominative subspecies restricted to the West Palaearctic and distributed mainly around the Mediterranean Sea (Alonso-Zarazaga 2013).

***Apterylobius* Marshall, 1942** (Figs 10C, D). Fewer than a dozen specimens of this genus are known, all exclusively from Mount Kinabalu in northern Borneo. Since its description (Marshall 1942), the genus contains two species and one non-nominative subspecies, and no newly collected specimens have been since reported.

***Carbonomassula* Heller, 1908** (Figs 10E, F, 16A). Specimens of this genus, apart from their much greater size, markedly resemble those of *Morimotodes* g. n. in having similarly evenly rounded and dorsally lustrous body of reddish or brownish color (compare Figs 6A and 10E). The genus contains the single species from Papua New Guinea, *C. glaberrima* Heller, 1908. The original description was based on an unknown number of syntypes and accompanied by a high quality habitus drawing (Heller 1908). The type locality is "Nova Guinea Britannica, ad flumen Aroa". Two syntypes are in MTD, the smaller one best fitting the body length given in the original description is illustrated herein (Figs 10E, F). Both syntypes have a blue rectangular label "14523" (Fig. 16A), even though the original description mentions "14525". One additional and seemingly conspecific specimen supplied to BMNH by M.E. Bacchus in 1965 has the locality label "NEW GINEA: Morobe Dist., Herzog Mts., Vagau, C.4,000 ft. 4–7.i.1965". No other specimens of this genus have been reported (Setliff 2007).

***Clarkantlus* Alonso-Zarazaga & Lyal, 1999** (Figs 10G, H, 16B). This genus consists of two poorly known species from Sri Lanka and the adjacent part of India. Its type species, *C. taprobanus* (Faust, 1895) was described from the holotype collected on "Ceylon". The genus has long been known under a preoccupied generic name *Ischnopus* Faust, year (non Amyot). Second species, *C. madraseusis* Pajni & Sood, 1982, was described from a holotype collected in the South Indian state of Tamil Nadu just across the Palk Strait from Sri Lanka. Except for the two type specimens, representatives of the genus have not been reported in the literature. Two additional historical specimens are present in MTD: one seemingly conspecific with the type species and labelled "Ceylon Plason" in Faust's handwriting, and another at least congeneric and with a printed label "India or. Madura". The locality might perhaps refer to the Madurai District in Tamil Nadu, which is the type locality of *C. madraseusis*. These four specimens are the sole representatives of this obscure genus.

***Euthycus* Pascoe, 1885** (Figs 11A, B). This genus embraces 12 species distributed at the junction between the Palaearctic and Oriental Regions and recorded from Japan, southern China and Taiwan, southwards to Borneo and Java, and westwards to Assam, Sikkim and Andaman Islands of India (Meregalli 2003). Little is known of their natural history, aside from appearing to be associated with mid-altitude primary mountainous forests. Observation of two live specimens personally collected by sifting litter in Taiwan and represented in the DNA analyses revealed remarkably strong adhesive power of their tarsi. This suggests that the beetles are climbers rather than true litter inhabitants (such as *Morimotodes* g. n.), where they might be encountered only accidently.

***Hadramphus* Broun, 1911** (Figs 11C, D). This genus includes four relatively large-bodied species restricted to New Zealand and some nearby islands and was revised by Craw (1999, including a summary on the immature stages and host plants). Together with *Lyperobius*, this genus can be considered as a weevil analogous to the moa or weta (i.e., flightless giant birds or crickets), that evolved

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Fig. 10. Representatives of the Molytini: Molytina genera. A–B: *Anisorhynchus barbatus* (Rossi), Italy, Abruzzo, no date, no collector, type species of *Anisorhynchus*, MTD; C–D: *Apterylobius basalis* (Heller, 1922), Malaysia, Borneo, no date, no collector, ?syntype, MTD; E–F: *Carbonomassula glaberrima* Heller, Papua New Guinea, syntype, see text, type species of *Carbonomassula*, MTD; G–H: *Clarkanthus taprobanus* (Faust), Sri Lanka, holotype, see text, type species of *Clarkanthus*, MTD.

in the unique New Zealand biota mostly deprived of terrestrial mammals and, therefore, highly vulnerable to invasive predatory species. Unlike the moa with all nine species quickly driven to extinction by invasive humans, all but one (*Tymbopiptus valeas* Kusehel, 1987) known large New Zealand weevils continue to survive, despite

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Fig. 11. Representatives of the Molytini: Molytina genera. A–B: *Euthycus macilentus* Pascoe, 1885, Indonesia, Java, Mt. Guntur, no date, Overbeck, type species of *Euthycus*, MTD; C–D: *Hadramphus tuberculatus* (Pascoe), New Zealand, Christchurch, 1910, no collector, BMNH, image: Vasily Grebennikov, © The Natural History Museum, London; E–F: *Leiosoma deflexum* (Panzer, 1795), Poland, Muszkowice, 6.v.1986, M.Wanat, type species of *Leiosoma*, CNC; G–H: *Liparus glabrirostris* (Küster, 1849), Poland, Sudetes, 15.vii.1975, M.Kupczyński, CNC.

loosing most of their former range (Kuschel & Worthy 1996). Recently an extant population of *H. tuberculatus* (Pascoe, 1877), a species thought to be extinct, was discovered (Fountain et al. 2013).

***Kyliparus* Moromoto, 1982** (not illustrated). This genus was proposed to accommodate a single species from Japan, *K. lewisii* (Roelofs), previously attributed to *Liparus*. The original description of *Kiliparus* contains a habitus dorsal image of a single female studied by Morimoto (1982, fig. 46E).

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***Leiosoma* Stephens, 1829** (Figs 11H, F). All 32 species and one non-nominative subspecies of this genus are restricted to the West Palaearctic, particularly the northern Mediterranean, with two species extended eastwards to the Caucasus (Alonso-Zarazaga 2013). Numerous species descriptions were made for localized allopatric populations and, therefore, a revision is desirable to assess their status as that of biologically valid entities.

***Liparus* Olivier, 1807** (Figs 11G, H), the type genus of the subtribe Molytina, the tribe Molytini and the subfamily Molytinae. The genus includes 17 species and two non-nominative subspecies (Alonso-Zarazaga 2014) of large-bodied weevils. The genus is most diverse in the West Palaearctic, while two species of the subgenus *Liparorhynchus* Reitter form the extreme eastward boundary of the generic distribution and are found in Central Asia (Uzbekistan, Tajikistan, Afghanistan, Iran; Bajtenov 1974; Alonso-Zarazaga 2013).

***Lyperobius* Pascoe, 1876** (Figs 12A, B). Along with *Hadramplus*, *Lyperobius* is another genus of large-bodied and flightless weevils endemic to New Zealand. The majority of its 16 species have highly restricted distributions due to human-induced habitat changes, including predation by introduced rodents (Craw 1999).

***Morimotodes* g. n.** (Figs 1–9). The genus includes two small-bodied litter species from Southwestern China and Taiwan, respectively, and is a sister to the West Palaeaerctic *Leiosoma*. See the taxonomic comments above.

***Pinacopus* Marshall, 1932** (Figs 12C, D). This genus has 14 named species found in Malaysia (8 spp.), Thailand (1 sp.), Laos (4 spp.) and northern India (1 sp.), with at least some specimens "collected from shrubs, which are more or less covered with lichens, by beating method" (Kojima 2010).

***Pterotomus* Quedenfeldt, 1888** (Figs 12E, F, 16C). The genus includes a single species, *P. moebiusi* Quedenfeldt, 1888, known from the holotype collected in Angola's province Malange and never reported since. The original description included a high quality habitus drawing (Quedenfeldt 1888).

Subtribe Plinthina

The subtribe Plinthina consists of 17 genera listed below. Eleven of them are restricted to the Mediterranean region and some, like *Minyops*, are also found in Central Europe, Ukraine, southern Russia and western Kazakhstan. Two genera, *Kurilio* and *Metalylobius*, with a total of three species are limited to the eastern Pacific (Honshu, Hokkaido and Kunashir). Four other inadequately known mono- and oligotypic genera are restricted to the Afrotropical Region, namely Seychelles (*Gonotrachelus*), East Africa (*Molytophilus* and *Pliuthinella*) and Madagascar (*Vouauxia*).

***Adexius* Schoenherr, 1834** (Figs 13A, B). This genus consists of three West Palaearctic species, two of them poorly known and narrowly distributed. The third one, *A. scrobipennis* Gyllenhal, 1834 is found in forest leaf litter in most of Central and Southern Europe between Belgium and Ukraine (Alonso-Zarazaga 2013).

***Alloplinthus* Solari, 1941** (Figs 13C, D). This genus consists of three species (originally described as *Plinthus*) from Tenerife and Gran Canaria (Alonso-Zarazaga 2013).

***Caulomorphus* Faust, 1886** (Figs 13E, F). The genus contains 11 eyeless species from Turkey, Greece, Iran and Azerbaijan (Alonso-Zarazaga 2013). Osella (1970) revised the genus taxonomically and later described three more species.

***Freyianus* Zumpt, 1932** (Figs 13G, H). This is a monobasic genus for *F. liparoides* Zumpt, 1932. It was described based on 10 syntypes (one of them adequately illustrated by a habitus photo) collected by "Kulzer" in "Ak-Schehir" (Zumpt 1932) and thought to be in Turkey (Alonso-Zarazaga & Lyal 1999). Since its description, this genus has not been reported in the original literature and its identity is inadequately known. The newly imaged specimen (Figs 13G, H), even if labelled as a "holotype", is in fact a syntype and, together with two other syntypes, is stored in NHMB.

***Gonotrachelus* Champion, 1914** (Figs 13I, J, 16D). The genus includes a single species, *G. quinquecarinatus* Champion, 1914 described from two syntypes found on the Seychelles (Long Island, near Mahé). An additional specimen of this species was reported from Madagascar (Hustache 1925). The genus is characterized by the funicle consisting of fine antennomeres (Champion 1914, figs 11, 11b) and was originally compared with *Styphloderes* Wollaston (Typoderini). The type series (presently in BMNH) was taken from seashores and was thought to be introduced via driftwood (Champion 1914).

***Hoplopteridius* K. Daniel, 1908** (Figs 14A, B). This genus consists of five species and three non-nominative subspecies distributed in the northern and eastern Mediterranean (Alonso-Zarazaga 2013).

***Iberoplinthus* Meregalli, 1986** (Figs 14C, D). This recently erected genus (Meregalli 1986) consists of six species (Alonso-Zarazaga 2013) all found in northern Spain, while

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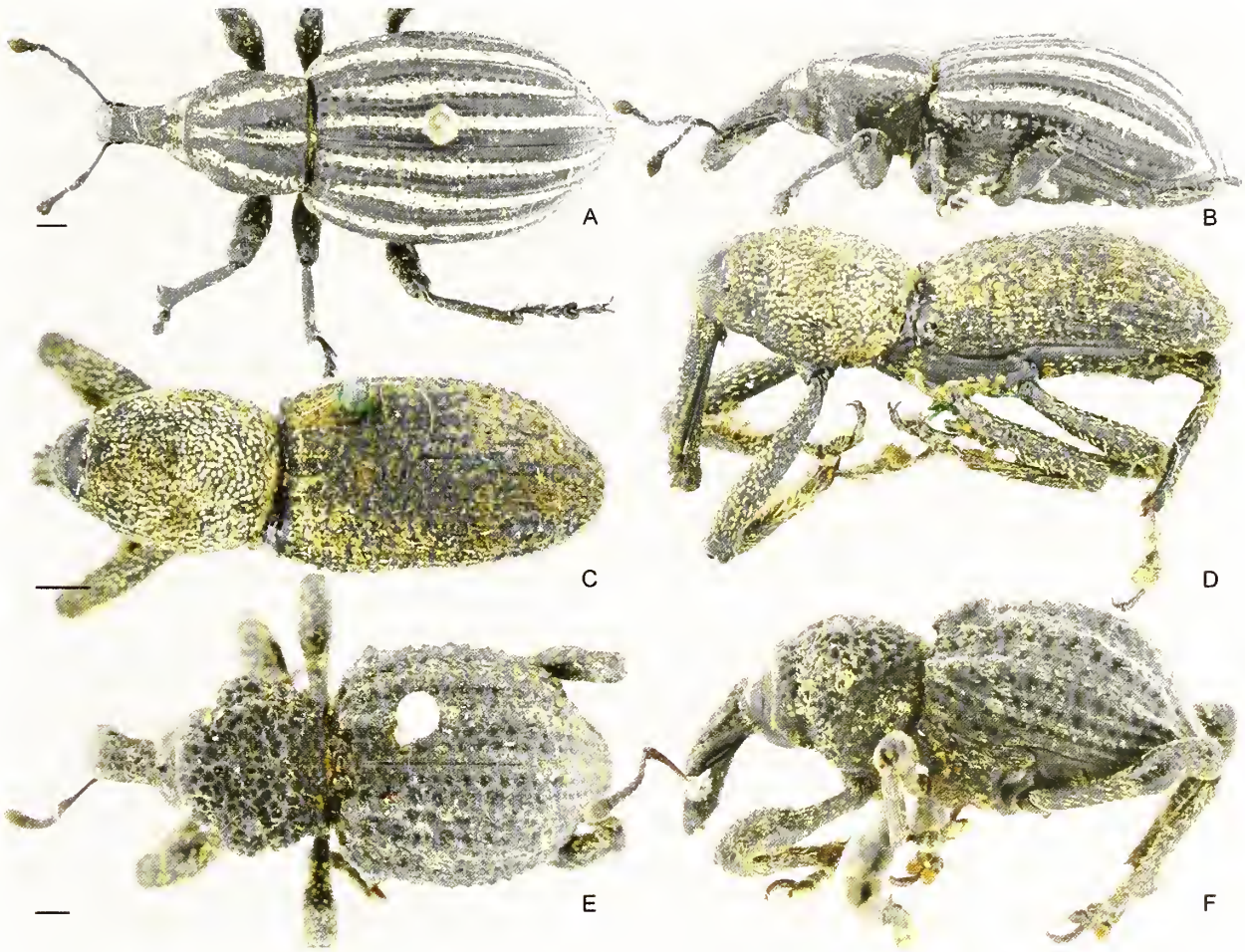

Fig. 12. Representatives of the Molytini: Molytina genera. A–B: *Lyperobius huttoni* Pascoe, 1876, New Zealand, Humboldt Mts., 30.xii.1944, C.E.Clarke, type species of *Lyperobius*, BMNH, image: Vasily Grebennikov, © The Natural History Museum, London; C–D: *Pinacopus dentirostris* Marshal, 1932, Malaysia, Perak, no date, no collector, MTD; E–F: *Pterotomus moebiusi* Quedenfeldt, Angola, holotype, see text, type species of *Pterotomus*, MNHN.

the type species, *I. imbricatus* (Dufur, 1851), and is reported also from Andorra and southern France.

***Kurilio* Zherikhin & Egorov, 1991** (Figs 14E, F). Its only species, *K. monachus* Zherikhin & Egorov, 1991, is restricted to Hokkaido and Kunashir Islands (Zherikhin & Egorov 1990).

***Metahylobius* Nakane, 1964** (Figs 14G, H). This genus consists of two species, both restricted to the alpine zone of Honshu: *M. jonensis* Nakane, 1964 and *M. rubiginosus* Morimoto, 1982. The adults of the former species "were captured by turning stones on the ground" (Morimoto 1982).

***Minyops* Schoenherr, 1823** (Figs 14I, J). This genus consists of 29 species and two non-nominative subspecies distributed through most of southern Europe and also Turkey (Alonso-Zarazaga 2013). The genus was recently taxonomically revised with 22 of its 31 species-group taxa described as new and eight others re-validated from synonymy (Osella & Bellò 2010).

***Mitoplinthus* Reitter, 1897** (Figs 15A, B). This genus consists of two species and one non-nominative subspecies of somewhat cylindrical medium-sized weevils distributed in southern parts of Europe between Spain and Ukraine. Meregalli (1986) provided the most recent treatment of the genus.

***Molytophilus* Hartmann, 1904** (Figs 15C, D). The genus consists of three species, the type species *Molytophilus carinatus* Hartmann, 1904, described from Tanzania, and two more from Ethiopia: *M. affinis* Hustache, 1936, and *M. puncticollis* Hustache, 1936, whose affinities with the genus have not yet been demonstrated.

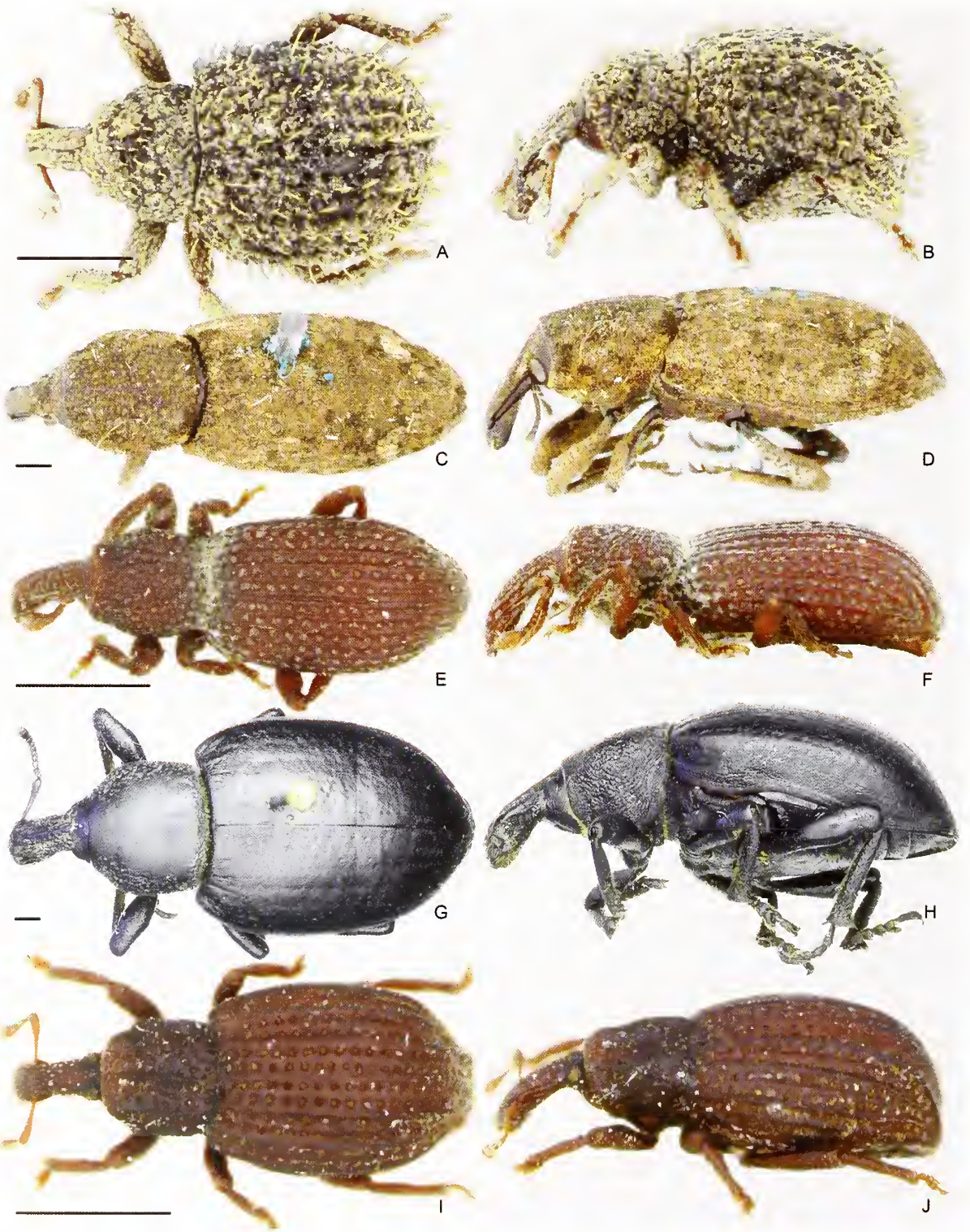

Fig. 13. Representatives of the Molytini: Plinthinae genera. A–B: *Adexius scrobipennis* Gyllenhal, Poland, Holubla ad Przemyśl, 4.vi.1997, M.Wanat, type species of *Adexius*, CNC; C–D: *Alloplinthus musicus* (Wollaston, 1860), Spain, Teneriffe, 17.v.1924, E.Appenhagen, type species of *Alloplinthus*, BMHN, image: Vasily Grebennikov, © The Natural History Museum, London; E–F: *Caulomorphus lederi* (Chevrolat, 1880), Georgia, "Meskiseh. Gb.", no date, H.Leder, ?syntype, type species of *Caulomorphus*, MTD; G–H: *Freyianus liparoides* Zumpt, Turkey, "Ak-Sehehir", 22.v.1926, Kulzer, syntype, type species of *Freyianus*, NHMB; I–J: *Gonotrachelus quinquecarinatus* Champion, Seyehelles, see text, syntype, type species of *Gonotrachelus*, BMNH, image: Vasily Grebennikov, © The Natural History Museum, London.

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Fig. 14. Representatives of the Molytini: Plinthinae genera. A–B: *Hoplopteridius lutosus* (Frivaldszky, 1835) Italy, Rom, no date, no collector, type species of *Hoplopteridius*, MTD; C–D: *Iberoplinthus curvirostris* Meregalli, 1986 Spain, Asturias, 14.vii.1986, M.Meregalli, paratype, BMNH, image: Vasily Grebennikov, © The Natural History Museum, London; E–F: *Kurilio monachus* Zherikhin & Egorov, Russia, Kunashir Isl., 16.ix.1975, no collector, type species of *Kurilio*, CNC; G–H: *Metahylobius jonensis* Nakane, Japan, Honshu Isl., 1.vii.1986, S.J.Martin, type species of *Metahylobius*, BMNH, image: Vasily Grebennikov, © The Natural History Museum, London; I–J: *Minyops carinatus* (Linnaeus, 1767), Austria, Wien, no date, no collector, type species of *Minyops*, MTD.

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Fig. 15. Representatives of the Molytini: Plinthinae genera. A–B: *Mitoplinthus caliginosus* (Fabricius, 1775), Germany, Arnstadt, 16.x.1949, W.Liebmann, MTD; C–D: *Molytophilus carinatus* Hartmann, Tanzania, Usambara, no date, no collector, syntype, type species of *Molytophilus*, MTD; E–F: *Neoplinthus tigratus porculus* (Fabricius, 1801), Austria, Graz, no date, no collector, MTD; G–H: *Plinthus confusus* Meregalli, 1985, Russia, Caucasus, 21.vi.1974, J.Vořišek, paratype, CNC; I–J: *Vouauxia onopatroidea* Hustache, Madagascar, see text, syntype, type species of *Vouauxia*, MNHN.

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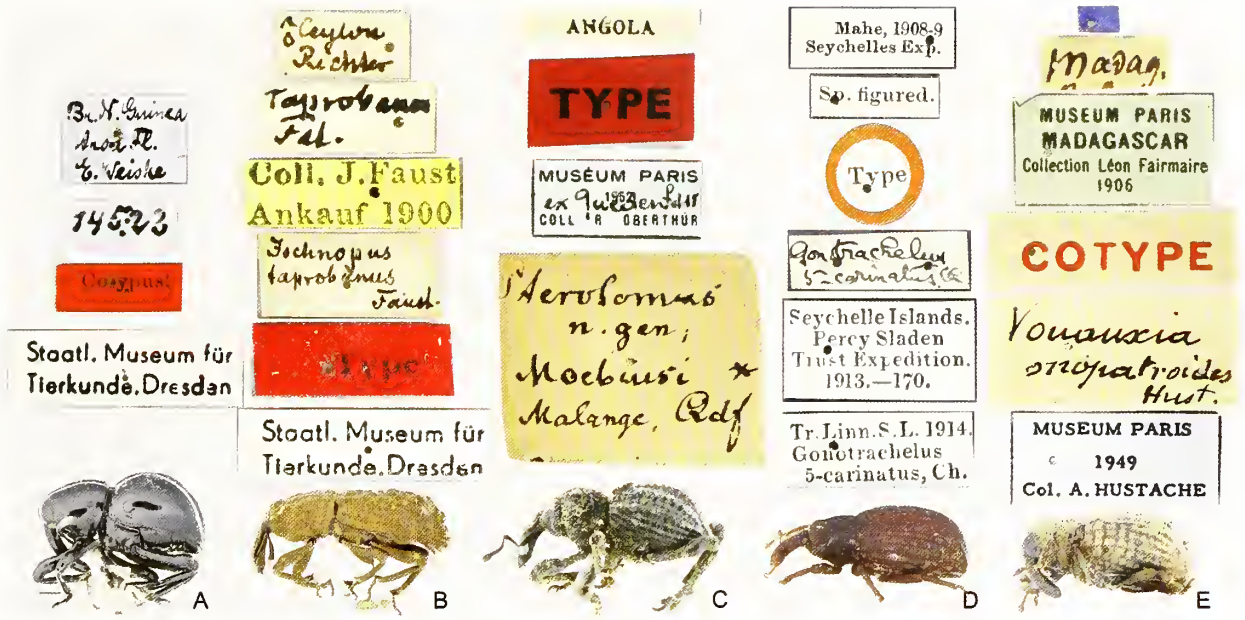

Fig. 16. Type specimen labels. A: *Carbonomassula glaberrima* Heller, ST; B: *Clarkanthus taprobanus* (Faust), holotype; C: *Pterotomus moebiusi* Quedenfeldt, holotype; D: *Gonotrachelus quinquecarinatus* Champion, syntype, image: Vasily Grebennikov, © The Natural History Museum, London; E: *Vonauxia onopatroidea* Hustache, syntype. Labels within each species are of proportional size; habitus images are not to scale.

***Neoplinthus* Bedel, 1884** (Figs 15E, F). This genus includes five species and two non-nominative subspecies of elongated and parallel-sided weevils distributed in Central, Eastern and Southern Europe; all of them recorded from Italy (Alonso-Zarazaga 2013).

***Paraminyops* Osella & Bellò, 2010** (not illustrated). This genus was recently separated from *Minyops* by Osella & Bellò (2010) to accommodate nine species and two non-nominative subspecies from northern and eastern Mediterranean.

***Plinthinella* Hofmann, 1965** (not illustrated). This genus includes its sole member, the type species by original designation *P. tenella* Hoffmann, 1965. This is a small beetle of some 2.0–2.2 mm in body length and funicle with seven antennomeres described from the holotype and 12 paratypes collected in 1962 by Herbert Frantz. The type locality in "Tanganyika: Kilimandjaro" (= Mt. Kilimanjaro in Tanzania) and the altitude is unknown. When described, this taxon was compared with *Marvaldiella glacialis* (Hustache, 1929) (cited as "*Minus glacialis*") from Mount Kenya in Kenya (depicted in Hustache 1929: fig. 15). Since its description, *Plinthinella tenella* has not been reported in the original literature and its identity is inadequately known. The curatorial search to locate the type series in NMW failed, while my extensive recent sampling in the type locality did not rediscover the species. Both the generic and species names should, therefore, be considered as *nomina dubia*.

***Plinthus* Germar, 1817** (Figs 15G, H). This genus includes 68 species and 17 non-nominative subspecies of medium- to large-bodied weevils widely distributed in the West Palaearctic. The majority of species are found in mountains between the Pyrenees and Alborz in northern Iran (Alonso-Zarazaga 2013). The Caucasus appears to have disproportionally large number of species normally restricted to alpine mountaintops. This is one of a few genera receiving significant attention in recent years, including detailed (although mainly unpublished) studies on internal classification, structure of male genitalia, species distribution and biology (Davidian 2008).

***Vonauxia* Hustache, 1920** (Figs 15I, J, 16E). The genus includes a single species, *O. onopatroidea* Hustache, 1920, described from Madagascar from unknown number of syntypes. The original brief description (Hustache 1920) was followed by a more detailed one (Hustache 1925), both relating this taxon to *Gonotrachelus* Champion. At least three syntype are present in MNHN. No other specimens of this genus have been reported in the literature.

CONCLUDING REMARKS

This review revealed, how little is actually known about wingless Molytinae genera, especially those, which are presently assigned to the subtribes Molytina and Plinthina. The discovery of a peculiar new genus from China strongly suggests that similar findings still remain to be made, especially using specialized collecting techniques

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and addressing specific habitats harbouring cryptic and small-sized organisms. Equally remarkable is the acute scarcity of data on the majority of other genera herein discussed. In many cases species and even genera were mentioned only once when formally described. Many mono- and oligobasic genera such as *Apterylobius*, *Carbonomassula*, *Clarkantlus*, *Kyliparus*, *Pterotomus*, *Freyianus*, *Gonotrachelus*, *Molytophilus*, *Plinthinella* and *Vouauxia* are particularly poorly known and at least some of them appear only distantly related to the type genera of their respective subtribes. A detailed morphological and, particularly, DNA analysis of Molytinae is indeed long overdue. Much remains to be done with wingless Molytinae weevils and hopefully this paper helps to reinforce this seemingly self-evident conclusion.

Acknowledgement. Aleš Smetana collected all specimens of *Morimotodes polynices* g. & sp. n. in Taiwan. Curators of the collections mentioned above variously helped in accessing specimens under their care. Genrikh Ed. Davidian (St. Petersburg, Russia) identified the sequenced specimens of *Plinthus*. Marek Wanat (Wrocław, Poland) sent imaged specimens of *Adexius, Liparus* and *Leiosoma*. Eva Sprecher contacted on my behalf Isabelle Zürcher-Pfander (both Basel, Switzerland), who counted syntypes and took images of *Freyianus liparoides* (Figs 13G, H). Thierry Deuve (Paris, France) sent a reprint of Hustache (1920). Bradley J. Sinclair and Eduard Jendek (both Ottawa, Canada) read an early draft of this work.

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New records of amphibians and reptiles from southern Vietnam

Truong Quang Nguyen[1,2], Trung My Phung[3], Nicole Schneider[4], Andreas Botov[4], Dao Thi Anh Tran[5,6] & Thomas Ziegler[4,*]

[1] *Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, 18 Hoang Quoc Viet, Hanoi, Vietnam; E-mail: nqt2@yahoo.com*

[2] *Department of Terrestrial Ecology, Zoological Institute, University of Cologne, Zülpicher Strasse 47b, D-50674 Cologne, Germany*

[3] *Dong Khoi 9A, Tam Hiep, Bien Hoa, Dong Nai Province, Vietnam; E-mail: pmytrung@yahoo.com*

[4] *AG Zoologischer Garten Köln, Riehler Strasse 173, D-50735 Cologne, Germany*

[5] *Vietnam National University, Ho Chi Minh City, University of Science, Faculty of Biology, 227 Nguyen Van Cu, District 5, HCM city, Vietnam; E-mail: ttadao.hcmuns@gmail.com*

[6] *Zoologisches Forschungsmuseum Alexander Koenig, Adenauerallе 160, D-53113 Bonn, Germany*

[*] *corresponding author: E-mail: ziegler@koelnerzoo.de*

Abstract. We report six new records of poorly known species of amphibians and reptiles on the basis of a new herpetological collection from southern Vietnam: *Ophryophryne gerti* and *Raorchestes gryllus* from Khanh Hoa Province, *Acanthosaura coronata* from Ba Ria – Vung Tau Province, *Gekko grossmanni* from Ninh Thuan Province, as well as *Cylindrophis ruffus* and *Oligodon cinereus pallidocinctus* from Binh Phuoc Province.

Keywords. *Ophryophryne gerti*, *Raorchestes gryllus*, *Acanthosaura coronata*, *Gekko grossmanni*, *Cylindrophis ruffus*, *Oligodon cinereus pallidocinctus*, new records, taxonomy.

INTRODUCTION

Geographic distribution records are crucial for assessing the conservation status and are also evidence to elucidate species' evolution and biology. Based on newly collected specimens of amphibians and reptiles from southern Vietnam, we herein report six new records of poorly known species, comprising two anuran species from Khanh Hoa Province, one agamid species from Ba Ria – Vung Tau, one geckonid species from Ninh Thuan Province as well as one cylindrophiid and one colubrid species from Binh Phuoc Province.

MATERIAL AND METHODS

Field work was conducted by Trung My Phung in Hon Ba Nature Reserve (Khanh Hoa Province) in July 2010, on Nui Dinh Mountain (Ba Ria – Vung Tau Province) in November 2008, in Ca Na forest (Ninh Thuan Province) in March 2010 and by Trung My Phung and Thang Huu Khuong in Bu Gia Map National Park in September and October 2011 (Fig. 1). After taking photographs, specimens were anaesthetized, fixed in 80-85% ethanol and subsequently stored in 70% ethanol. Specimens were deposited in the collections of the Institute of Ecology and Biological Resources (IEBR) and Vietnam National Museum of Nature (VNMN), Hanoi, Vietnam and the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany.

Measurements of specimens were taken with a digital caliper to the nearest 0.1 mm. Abbreviation are as follows: SVL (snout-vent length): from tip of snout to anterior margin of cloacal; TaL (Tail length): from posterior margin of cloacal to tip of tail; TL (total length): SVL + TaL. Terminology of morphological characters followed Nguyen et al. (2012) for amphibians (except for forearm length, FAL: from axilla to elbow and hand length, HAL: from base of outer palmar tubercle to tip of finger III), Phung & Ziegler (2011) for lizards, and David et al. (2012) for snakes.

RESULTS AND DISCUSSION

Taxonomic accounts

Megophryidae

***Ophryophryne gerti* Ohler, 2003**
Gerti's Mountain Toad / Coc nui got (Fig. 2)

Specimens examined: VNMN 983 and ZFMK 94220, males, collected by T. M. Phung on 4 July 2010 from Hon Ba Nature Reserve (ca. 12°10'N, 109°02'E), Dien Khanh District, Khanh Hoa Province.

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Fig. 1. Map of sampling sites in southern Vietnam: 1) Khanh Hoa Province, 2) Ninh Thuan Province, 3) Binh Phuoc Province, 4) Ba Ria – Vung Tau Province.

Morphological characters: Size small, SVL 28.2–29.7 mm (n = 2); head wider than long (HW 8.5–8.9 mm, HL 8.1–8.7 mm); snout truncate, protruding, shorter than horizontal diameter of eye (SL 2.6–2.7 mm, ED 3.2–3.7 mm); canthus rostralis rounded, loreal region convex; interorbital distance narrower than upper eyelid and internarial distance (IOD 4.0–4.3 mm, UEW 2.6–2.7 mm, IND 2.5–2.7 mm); nostrils closer to the eye than to the tip of snout (EN 1.1–1.4 mm, SN 1.2-1.5 mm); pupil rounded; tympanum oval, greater than half eye diameter and tympanum-eye distance (TD 1.8–2.3 mm, TYE 1.5–1.9 mm); supratympanic fold distinct; vomerine teeth absent; tongue rounded posteriorly.

Forelimbs: FAL 6.5–7.4 mm, HAL 7.5–7.6 mm; fingers free of webbing, relative length of fingers: I<II=IV<III; tips of fingers rounded, without discs; dermal fringe along outer finger absent; subarticular tubercles absent; palmar tubercles indistinct. Hindlimbs: femur longer than tibia and foot length (FML 15.3–18.7 mm, TBL 14.9–15.2 mm, FTL 12.7–13.3 mm); toes long and thin, relative length of toes: I<II<V<III<IV; tips of toes rounded; webbing basal; dermal fringe along outer toe absent; subarticular tubercles absent; inner metatarsal tubercle small (IMT 1.4–1.5 mm), outer metatarsal tubercle absent, tarsal fold absent.

Dorsal skin of head, body and limbs granular; dorsum with several skin ridges, forming a X-shape in the middle and two other ridges running from behind tympanum to posterior part of back; lateral sides of head and flank granular, upper part of flank with some glandular warts; orbital horn pointed; dorsolateral fold absent; throat, chest, belly and ventral surface of limbs smooth; pectoral and femoral glands present, small.

Coloration in life: Dorsal surface of head and body dark brown; a dark triangular pattern between eyes present; lower part of flank with some dark brown spots; lateral side of head dark brown; dorsal surface of limbs with dark bars; throat, chest, belly and ventral surface of limbs dark brown with some black spots.

Remarks: Morphological characters of our specimens agreed well with the description of Ohler (2003) but they are a little smaller than the type series (SVL 28.2–29.7 mm vs. 32.0–45.8 mm).

Distribution: In Vietnam, this species is known from Thua Thien – Hue Province southward to Lam Dong Province. Elsewhere, this species has been reported from Laos (Nguyen et al. 2009).

Rhacophoridae

***Raorchestes gryllus* (Smith, 1924)**
Langbian Bubble-nest Frog / Nhai cay Langbian (Fig. 3)

Specimens examined: VNMN 985 (adult female), VNMN 986 and ZFMK 94221-94222 (adult males), collected by T. M. Phung on 4 July 2010 from Hon Ba Nature Reserve (ca. 12°10'N, 109°02'E), Dien Khanh District, Khanh Hoa Province.

Morphological characters: Size small, SVL 21.9–24.2 mm (n = 4), head as long as wide (HL 9.2–9.8 mm, HW 9.2–9.8 mm); snout pointed in dorsal view, a bit longer than horizontal diameter of eye (SL 3.6–4.1 mm, ED 3.1–3.5 mm); canthus rostralis distinct; interorbital distance wider than internarial distance and upper eyelid (IOD 2.4–2.7 mm, IND 1.7–2.0 mm, UEW 2.3–2.4mm); nostril lateral, rounded, nearly midway between tip of snout and eye (SN 1.6–1.8 mm); vomerine teeth absent; tympanum rounded, smaller than half of eye diameter but

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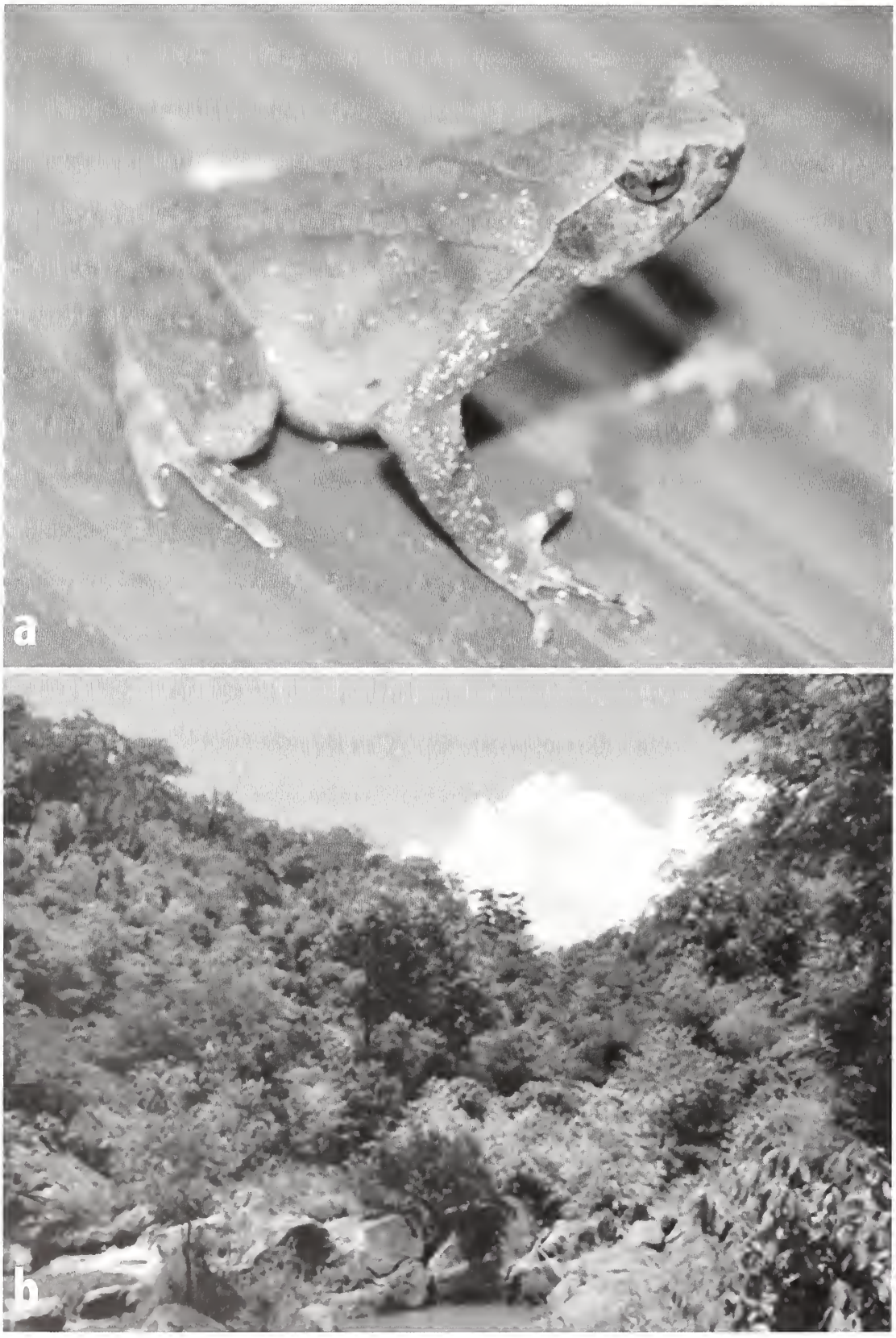

Fig. 2. Gerti's Frog *Ophryophryne gerti* (a) and its habitat (b). Photos: Trung M. Phung.

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Fig. 3. Langbian Bubble-nest Frog *Raorchestes gryllus* (a) and its habitat (b). Photos: Trung M. Phung.

greater than tympanum-eye distanee (TD 1.2–1.3 mm, TYE 0.4–0.6 mm); supratympanie fold distinet; tongue notched posteriorly.

Forelimbs: FAL 4.0–4.2 mm, HAL 6.6–7.7 mm; finger webbing basal, relative length of fingers: I<II<IV<III; tips of fingers enlarged into round dises, with eireummarginal grooves; subartieular tubereles rounded and prominent; series of tubereles present along outer side of forearm and finger IV; nuptial pad present in males.

Hindlimbs: femur as long as tibia but longer than foot length (FML 11.3–12.4 mm, TBL 11.2–12.3 mm, FTL 9.5–10.3 mm); relative length of toes: I<II<III<V<IV; tips

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Fig. 4. Coronated Tree Lizard *Acanthosaura coronata* (a) and its habitat (b). Photos: Trung M. Phung.

of toes with enlarged dises; subartieular tubereles prominent; inner and outer metatarsal tubercles present; webbing formula: I2-2II1⅓-2½III1¾-2IV2-1V; tubereles present along outer margins of tibia, foot and toe V; tibiotarsal artieulation reaehing to eye.

Dorsal skin eovered by tiny tubereles; throat finely granular; belly and ventral surfaee of thigh eoarsely granular, small tuberele present on heel.

Coloration in life varied among individuals: Baekground of dorsal surfaee of head, body and limbs of males light brown with reddish brown or bright green marbling; a bright green triangle pateh, eovering anterior part of upper eyelid and snout, sometimes the pateh eombined with the posterior bright green marbling; dorsum with two dark brown stripes, forming a ")(" shape, from rear of eye to groin, distinet or indistinet; dorsal surfaee of limbs with dark brown transverse bars; throat, chest and belly white. Female uniform green above and whitish beneath.

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Remarks: Our specimens differ from previous descriptions (Smith 1924, Orlov et al. 2012) by having dermal fringe along outside of tarsus less developed (versus well developed in description of Orlov et al. 2012). Iris light golden with brown or reddish mottles posteriorly, pupil horizontal oval and black (not mentioned by Smith 1924 and Orlov et al. 2012). Specimens of *R. gryllus* from Khanh Hoa Province are morphologically similar to *Kurixalus viridescens*, a newly described species from southern Vietnam by Nguyen et al. (2014). However, *R. gryllus* can be distinguished from the latter by the following characters: the presence of a brown)(-shaped marking on dorsum and upper part of flank (versus uniform solid green dorsum in *K. viridescens*), outer metatarsal tubercle present (versus absent in *Kurixalus viridescens*); toe webbing formula I2-2II1⅓-2½III1¾-2IV2-1V (versus I2-2¾II1½-2¾III1½-3IV2½-1¾V in *K. viridescens*), and the iris light golden with brown or reddish mottles posteriorly (versus golden with some black reticulations in *K. viridescens*).

Distribution: In Vietnam, *R. gryllus* was orginally discovered from Langbian Plateau, Lam Dong Province by Smith (1924). This species was also reported from northern Vietnam: Lao Cai, Ha Giang, Cao Bang, Tuyen Quang, Lang Son, Vinh Phuc, Thai Nguyen and Thanh Hoa provinces as well as from central provinces: Dak Lak, Gia Lai, Kon Tum (Nguyen et al, 2009). This is the first record of *R. gryllus* from Khanh Hoa Province. Elsewhere, it has been known from Champasak Province of Laos (Frost 2014, and Orlov et al. 2012).

Agamidae

***Acanthosaura coronata* Günther, 1861**
Coronated Tree Lizard / O ro vanh (Fig. 4)

Specimen examined: One adult female, collected by T. M. Phung on 1 November 2011 from Nui Dinh Mountain (ca. 10°30'N, 107°07'E), Tan Thanh District, Ba Ria – Vung Tau Province. This specimen was released after examining of morphogical characters.

Morphological characters: SVL 90 mm, TaL 125.9 mm (n=1); forepart of head deeply concave; scales on upper head inhomogeneous, obtusely keeled, much smaller in size in posterior part; canthus rostralis and supraciliary edge distinct; a long spine behind the eye present; another spine on the back of the head present, mid-way between tympanum and nuchal crest; tympanum one-third to one-half the diameter of orbit; 10–13 supralabials.

Dorsal scales small, keeled, intermixed with much larger, strongly keeled scale; scales on upper rows larger in size, pointing upwards, lateral scales pointing backwards and upwards, sometimes downwards; ventrals as large as the largest dorsal scales, strongly keeled; gular sac absent; gular scales strongly keeled, smaller than the ventrals; a strong oblique fold present in front of shoulder; nuchal crest with triangular spines; dorsal crest continuous with the nuchal crest, reduced as a prominent ridge, composed of broad scales; hind limb extending to the tip of the snout. Tail compressed, subtriangular at base, covered with keeled scales above, strongly keeled and elongated scales below.

Coloration in life: Dorsal surface of head and body dark grey; dorsum and tail base with four light bands, edged by black posteriorly; head light green or yellow; a dark cross-bar present between eyes; some dark lines radiating from eyes; belly cream (identification after Smith 1935).

Distribution: In Vietnam, this species has been known from Dak Lak, Lam Dong, and Dong Nai provinces. Elsewhere, it was reported from Cambodia (Nguyen et al. 2009).

Gekkonidae

***Gekko grossmanni* Günther, 1994**
Grossman's gecko / Tac ke g-ro-s-man (Fig. 5)

Specimens examined: VNMN 960 (male), VNMN 959 and ZFMK 94125-94126 (females), collected by T. M. Phung on 27 March 2010 from Ca Na forest (ca. 11°19'N, 108°49'E), Ninh Phuoc District, Ninh Thuan Province.

Morphological characters: SVL 71–86 mm, TaL 84.8–101.6 mm (n=4); head longer than wide (HL 20–23.9 mm, HW 13.1–17.2 mm), axillary-groin distance 29.2–34.4 mm.

Rostral wider than high, rarely with X- or Y-shaped suture, touching nostril; supranasals 2 (rarely 3); internasals 0–1; interorbital scales between anterior corners of eyes 40–45; supralabials 11–12, infralabials 9–10; dorsum covered by small, unequal granular scales interspersed, flat or slightly keeled tubercles; midbody scales rows 118–122; tubercles surrounded by 9 scales, in 11–13 rows at midbody; tubercles absent on upper surface of limbs and tail; lateroventral fold distinct; ventral scale rows between lateral folds 29–31; ventral scales along underside of body from mental to the cloacal slit 156–162; subcaudals 86–91, enlarged; precloacal pores 13 (in male), femoral pores absent; finger and toe webbing basal; subdigital lamellae 10–14 under the first finger, 16–18 under the fourth finger, 11–15 under the first toe, 17–18 under the fourth toe.

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Fig. 5. Grossmann's Gecko *Gekko grossmanni* (a) and its habitat (b). Photos: Trung M. Phung.

Coloration in life: Dorsal surfaee of head, body and tail grey intermixed with yellow dots and dark brown marbling; dorsum with several rows of 7–8 light grey spots: one along vertebral and two others on eaeh side; light bands present on upper surface of tail (identification after Günther 1994, in eomparison with Ngo & Gamble 2011).

Distribution: This speeies has been known only from the type loeality in Khanh Hoa Provinee, Vietnam (Nguyen et al. 2009).

Cylindrophiidae

***Cylindrophis ruffus* (Laurenti, 1768)**
Red-tailed Pipe Snake / Ran trun (Fig. 6a)

One speeimen was photographed by T. H. Khuong in Oetober 2011 in Bu Gia Map National Park (ea. 12°10'N, 107°12'E), Binh Phuoe Province.

Identifieation is based on the eharaeteristie body shape and colour pattern (after Smith 1943): head depressed, snout round; tail very short. Coloration in life: dorsal head

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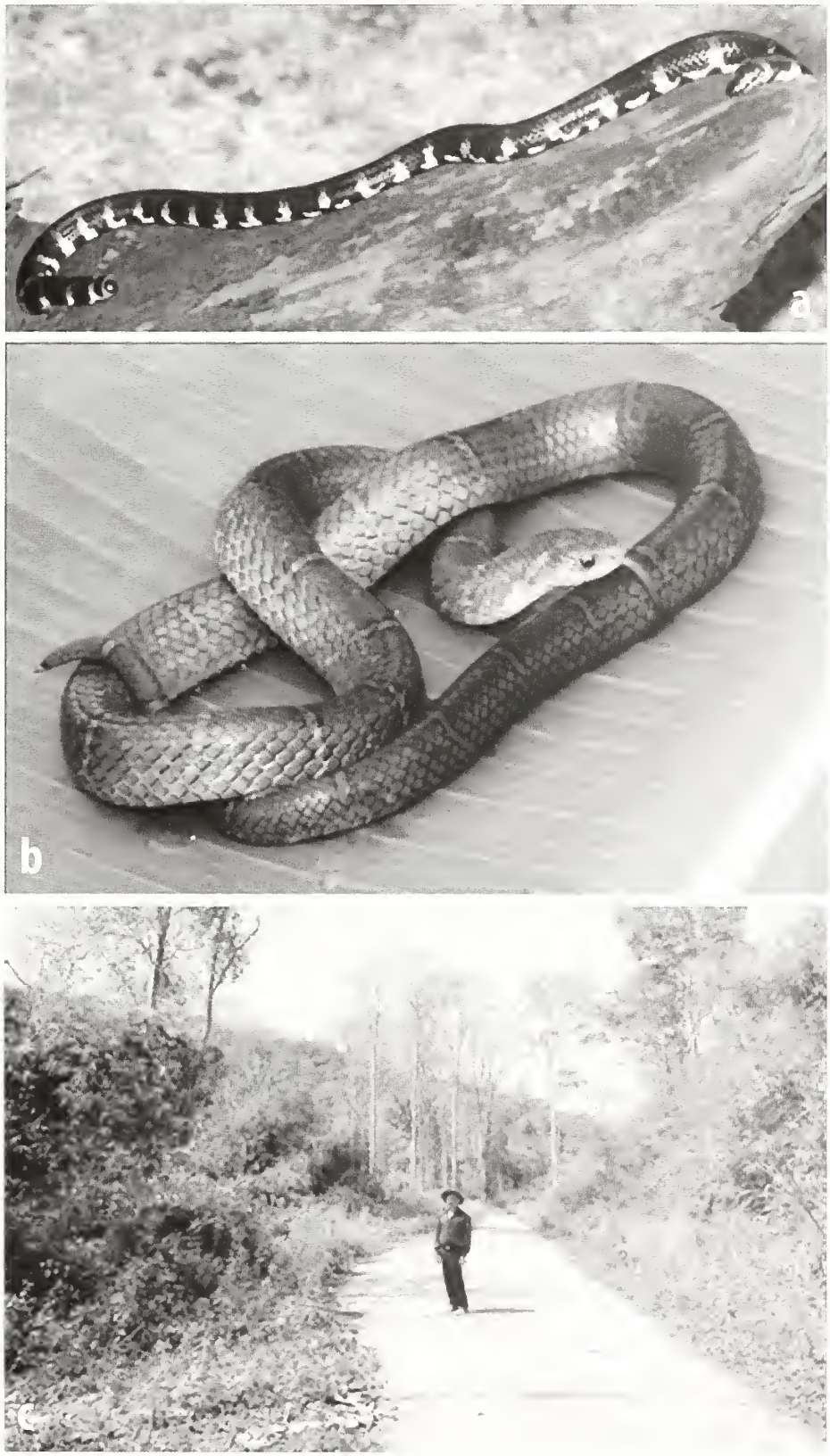

Fig. 6. Red-tailed Pipe Snake *Cylindrophis ruffus* (a) and Guenther's Kukri Snake *Oligodon cinereus pallidocinctus* (b) and its habitat (c). Photos: Thang H. Khuong.

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and body blackish brown, iridescent, with narrow light cross-bars, extending to the middle of the back; an orange ring present near the tip of tail; venter black with white bars; ventral surface of tail with orange bars.

Distribution: In Vietnam, this species is known from Vinh Phuc Province in the North southwards to Ca Mau Province. Elsewhere, it has been recorded from China, Myanmar, Thailand, Laos, Cambodia, Malaysia, Singapore, and Indonesia (Nguyen et al. 2009).

Colubridae

***Oligodon cinereus pallidocinctus* (Bourret, 1934)**
Guenther's Kukri Snake / Ran khiem xam (Fig. 6b,c)

Specimens examined: IEBR A.2012.8, adult female, collected by T. M. Phung and T. H. Khuong on 12 September 2011 from Bu Gia Map National Park (ca. 12°10'N, 107°12'E), Binh Phuoc Province.

Morphological characters: SVL 540 mm, TaL: 72 mm; maxillary teeth 12/12; loreal 1/1; supralabials 8/8, fourth and fifth entering orbit; infralabials 8/8; preocular single; postoculars 2; temporals 1+2; dorsal scale rows 17-17-15, smooth; cloacal entire; ventral scales 183, subcaudals 34, divided.

Coloration in life: Dorsal head with a grey chevron; dorsal surface of body reddish brown with 26 grey, black-edged bands on body, 4 bands on tail; ventral surface cream with dark spots (identification after Bourret 1936 and Smith 1943).

Remarks: The female specimen differs from the description of Bourret (1936) in having more ventrals (183 versus 176), fewer subcaudals (34 vs. 40). Smith (1943) mentioned the number of light bands of this subspecies to be varying from 27–34 on body and 3-4 on tail. Because the intraspecific taxonomy of *Oligodon cinereus* remains unresolved (David et al. 2011), we provisionally considered *pallidocinctus* as a subspecies of this species.

Distribution: In Vietnam, this subspecies is known from Thua Thien – Hue and Ba Ria – Vung Tau provinces, and Ho Chi Minh City ("Form IV" in Smith 1943). Elsewhere, *Oligodon cinereus* has a wide range from India and China throughout the Indochina region southward to Thailand (Nguyen et al. 2009).

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Towards an improved knowledge of Sericini of the Tibetan highland: new species and records (Coleoptera: Scarabaeidae)

Wan-Gang Liu[1,2], Ming Bai[1], Xing-Ke Yang[1] & Dirk Ahrens[3]

[1] *Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Box 92, No. 1, Beichen West Road, Chaoyang District, Beijing, 100101, P.R. China*

[2] *Graduate School, Chinese Academy of Sciences, Yuquan Road, Shijingshan, Beijing, 100039, P.R. China*

[3] *Zoologisches Forschungsmuseum A. Koenig, Adenauerallee 160, D-53113 Bonn, Germany; E-mail: d.ahrens@zfmk.de*

Abstract. Nine new species of Sericini are described from Tibetan highlands: *Calloserica zhangmuensis* Liu & Ahrens sp. n., *Gynaecoserica hani* Liu & Ahrens sp. n., *G. yigongensis* Liu & Ahrens sp. n., *Lasioserica beibengana* Liu & Ahrens sp. n., *Nepaloserica nielamuensis* Liu & Ahrens sp. n., *Neoserica* (s.l.) *chayuensis* Liu & Ahrens sp. n., *N.* (s.l.) *xizangensis* Liu & Ahrens sp. n., *Serica* (s.l.) *fashengi* Liu & Ahrens sp. n., *S.* (s.l.) *yadongensis* Liu & Ahrens sp. n. Records are given for further 25 species, most of them being for the first time recorded from Tibet. Distribution maps of these new species and records are shown along illustrations of habitus and male copulatory organ of the newly described taxa.

Key words. Beetles, chafers, China, new species.

INTRODUCTION

The taxonomy of the fauna of sericine chafer beetles (Sericini) of the Himalayas and Tibetan highland was revised and reviewed in detail by Ahrens (2004). Subsequently, new data and taxa were added (Ahrens 2005a–e, 2006c, Ahrens & Fabrizi 2009a,b, 2011, Ahrens & Pacholátko 2005) and a number of phylogenetic studies explored the diversification and biogeographic patterns of the Himalayan Sericini fauna (Ahrens 2005d, 2006a,b,d–f, 2007a,b). But we have to consider the eastern regions of the Himalaya and the adjacent mountain regions of northern Myanmar and southwest China including the Tibetan highland still to be relatively unexplored. This fact hampers more rigorous hypotheses on the diversification of the Himalayan fauna.

In this paper, we survey the material hold in Chinese institutional collections resulting in nine new species and records for further 25 species, most of them being the first time recorded from Tibet.

MATERIAL AND METHODS

The terminology and methods used for measurements, specimen dissection and genital preparation follow Ahrens (2004). Data from specimens examined is cited in the text with original label contents given in quotation marks, multiple labels are separated by a "/". Descriptions are based on holotype specimen if not otherwise stated. The variation of paratypes is given separately. Male genitalia were glued to a small pointed card attached to the specimen. Descriptions and illustrations of new taxa are based on the holotype specimen, while the variation of other specimens is given separately under variation. All descriptions and measurements were made under an Olympus SZX 12 microscope, and all genital and habitus illustrations were made with a digital camera (AxioCam HRc) attached to a stereo microscope (Zeiss Stereo Discovery V20) and Axio Version 4.8 software. The distribution map was generated using Q-GIS 2.0.1 and Adobe Photoshop CS4.

Type specimens and other examined material are deposited in the following institutions:

CAU	Department of Entomology, China Agricultural University, Beijing (China);
HBUM	Museum of Hebei University, Baoding (Hebei Prov., China);
IZAS	Institute of Zoology, Chinese Academy of Sciences, Beijing (China);
NKU	Nankai University, (Tianjin Prov., China);
NWAFU	Northwest A & F University, Yangling (Shaanxi Prov., China);
ZFMK	Zoologisches Forschungsmuseum A. Koenig, Bonn (Germany).

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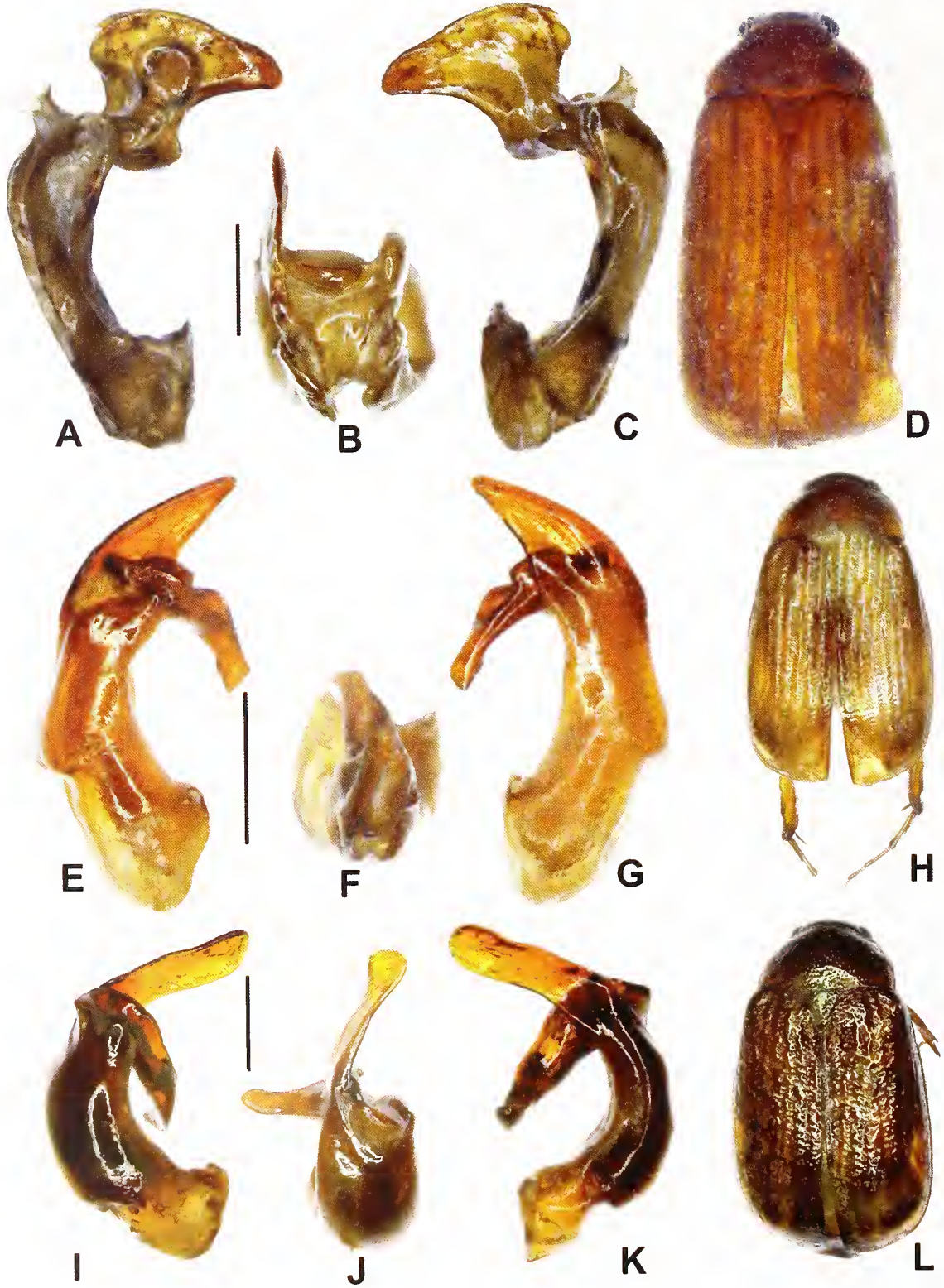

Fig. 1. A–D: *Calloserica zhangmuensis* Liu & Ahrens sp. n. (holotype), E–H: *Gynaecoserica hani* Liu & Ahrens sp. n. (holotype), I-K: *G. yigongensis* Liu & Ahrens sp. n. (holotype). A, E, I: Aedeagus, left side lateral view; C, G, K: Aedeagus, right side lateral view; B, F, J: Parameres, dorsal view; D, H, K: Habitus (not to scale). Scale: 0.5 mm.

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***Calloserica zhangmuensis* Liu & Ahrens sp. n.**

Type material examined. Holotype: ♂ [China] "Zhangmu, Xizang, 28.VI.1975, 2200m, leg. Wang Ziqing" (IZAS). Paratypes: 1 ♂ [China] "Zhangmu, Xizang, 24.VI.1975, 2200m, leg. Wang Ziqing" (ZFMK), 1 ♀ [China] "Zhangmu, Xizang, 5.VII.1975, 2400m, leg. Huang Fusheng" (IZAS), 1 ♀ [China] "Zhangmu, Xizang, 28.VI.1975, 2200m, leg. Wang Ziqing" (IZAS).

Description. Length: 8.0 mm, length of elytra: 6.2 mm, width: 4.0 mm. Body oblong and dull, dorsal surface, ventral surface and legs reddish brown, elytral intervals, head and pronotum darker; dorsal surface with moderately long and very dense setae being directed anteriorly, with a few longer erect setae on head and pronotum, even intervals with large spots composed of minute white, scale-like setae.

Labroclypeus short, trapezoidal, widest at base, lateral margins convex and moderately convergent from base to broadly rounded anterior angles, anterior margin strongly concavely sinuate, labrum strongly produced medially, lateral border and ocular canthus producing a distinct obtuse angle, all margins moderately reflexed; surface flat and shiny, finely and densely punctate, with several long erect setae in larger punctures; frontoclypeal suture moderately impressed and curved, smooth area anterior to eye 1.5 times as wide as long; ocular canthus long and narrow, finely and densely punctate, glabrous, terminal seta lacking. Frons moderately densely and finely punctate, punctures shortly and erectly setose, with a few long erect setae setae beside eyes. Eyes small, ratio of diameter/ interocular width: 0.61. Antenna missing in holotype. Mentum elevated and flattened anteriorly.

Pronotum widest at base, lateral margins evenly convex and convergent anteriorly, anterior angles moderately rounded, not produced and nearly obsolete, anterior margin straight, without marginal line, basal margin without marginal line; surface with very dense and fine punctures each bearing a yellow fine and erect seta, partly with longer erect setae, midline not impressed, with a weak transverse impression behind middle; anterior border finely setose, setae of lateral margins lacking; hypomeron carinate, basal margin of hypomeron distinctly produced ventrally. Scutellum subtriangular, apex moderately rounded, with fine and dense punctures and fine setae, impunctate on basal midline.

Elytra oblong, widest at middle, striae moderately impressed, with fine and dense punctures; intervals flat, with evenly distributed, fine and dense punctures, finely and erectly setose, with numerous longer setae on each interval, even intervals with large spots composed of minute white, scale-like setae; epipleural edge moderately strong, ending at strongly rounded external apical angle of elytra, epipleura densely setose, apical border chitinous, without short microtrichomes.

Ventral surface with large and dense punctures, including metacoxa with fine adpressed setae. Abdominal sternites finely and densely punctate and finely setose, each sternite with an indistinct transverse row of coarser punctures each bearing a short, robust seta. Penultimate abdominal sternite flat, without transverse elevation posteriorly. Mesosternum between mesocoxae as wide as mesofemur, with numerous strong setae on an indistinct semicircular carina. Ratio of length of metepisternum/ metacoxa: 1/ 1.38. Pygidium moderately convex, with fine and dense punctures each bearing a fine short seta, with a few longer setae on apical half, midline narrowly smooth, apical margin slightly reflexed.

Legs slender and moderately shiny, femora finely and densely punctate, densely setose. Tarsomeres glabrous and impunctate dorsally, with sparse, short setae ventrally. Posterior legs missing in holotype. Protibia moderately long, bidentate, protarsal claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Aedeagus: Fig. 1A–C.

Diagnosis. The new species resembles in genital morphology mostly *C. poggii* Ahrens, 1995. It differs by the much shorter basomedian process of parameres, the smaller left paramere (in lateral view) as well as the apparently shorter phallobasis.

Variation. Length: 7.4–8.9 mm, length of elytra: 6.2–7.4 mm, width: 3.6–4.8 mm. Anterior edge of metafemur acute, lacking an adjacent serrated line, posterior margin weakly convex, with numerous strong setae medially, weakly widened ventrally in apical half but not serrate, serrate dorsally, with short setae. Metatibia moderately long, widest at apex, ratio width/ length: 1/4.2, dorsal margin sharply carinate, with two groups of spines, basal group shortly before middle, apical one at three quarters of metatibial length, with a few single spines basally; lateral face longitudinally convex, with a few sparse and coarse punctures, ventral edge finely serrate, with three robust equidistant setae; medial face impunctate and smooth, apex concavely truncate interiorly near tarsal articulation. Metatarsomeres smooth dorsally, with a strongly serrated ridge ventrally and a lateral longitudinal carina, first metatarsomere as long as following two tarsomeres combined and little less than twice as long as dorsal tibial spur. Female: antennal club with three antennomeres, as long as remaining antennomeres combined.

Etymology. The new species is named after the type locality, Zhangmu.

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***Gynaecoserica hani* Liu & Ahrens sp. n.**

Type material examined. Holotype: ♂ [China] "Beibeng, Motuo, Xizang, 17.V.1983, 850m, leg. Han Yinheng" (IZAS). Paratype: 1 ♀ [China] "Beibeng, Motuo, Xizang, 17.V.1983, 850m, leg. Han Yinheng" (IZAS).

Description. Length: 5.2 mm, length of elytra: 3.9 mm, width: 3.1 mm. Body oblong, shiny, including antenna yellowish brown, pronotum, frons and metasternum darker, dorsal surface except a few setae on head glabrous.

Labroclypeus narrow, widest at base, lateral margins strongly convex and convergent from base to moderately rounded anterior angles, lateral margin and ocular canthus producing a distinct obtuse angle, anterior margin weakly sinuate medially, margins weakly reflexed; surface weakly convex medially and moderately shiny, coarsely and densely punctate, with several long erect setae behind anterior margin; frontoclypeal suture moderately impressed and curved, smooth area anterior to eye 1.5 times as wide as long; ocular canthus short and moderately narrow, impunctate, with a short terminal seta. Frons with moderately dense punctures, glabrous, only beside each eye with a single long seta. Eyes small, ratio of diameter/ interocular width: 0.6. Antenna with ten antennomeres, club with four antennomeres, as long as remaining antennomeres combined. Mentum elevated and flattened anteriorly.

Pronotum widest at base, lateral margins nearly straight and evenly and moderately convergent anteriorly, in anterior third slightly convex and more strongly convergent, anterior angles distinctly produced and sharp, posterior angles blunt, anterior margin convexly produced medially, with a fine marginal line, basal margin without marginal line; surface with dense and coarse punctures, on sides with minute setae, midline not impressed; anterior and lateral borders sparsely setose; hypomeron carinate, basal margin of hypomeron not produced ventrally. Scutellum subtriangular, apex moderately rounded, with fine, dense punctures and minute setae, smooth medially.

Elytra oblong, widest at middle, striae moderately impressed, with fine and dense punctures; intervals weakly convex, with fine and dense punctures concentrated along striae; epipleural edge moderately strong, ending at bluntly rounded external apical angle of elytra, epipleura sparsely setose, apical border chitinous, without short microtrichomes.

Ventral surface partly dull laterally, with large and dense punctures, sparsely setose, metacoxa only laterally with a few fine adpressed setae. Abdominal sternites finely and densely punctate, nearly glabrous, each sternite with a distinct transverse row of coarse punctures each bearing a short robust seta. Mesosternum between mesocoxae as wide as mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.59. Pygidium shiny, beside apical margin dull, surface moderately convex, with fine, dense punctures and fine, moderately long setae beside apical margin, without smooth midline.

Legs moderately long; femora shiny, with two longitudinal rows of setae, finely and sparsely punctate; anterior edge of metafemur acute and without a submarginal serrate line, posterior margin weakly convex, ventral part smooth and glabrous, only weakly widened in apical half and not serrate, dorsal margin finely serrate and with fine short setae. Metatibia slender and moderately long, uniformly widened towards apex, ratio width/ length 1/ 2.94, dorsal margin sharply carinate, longitudinally convex only basally, with two groups of spines, basal group at one third, apical group at two thirds of metatibial length, with a few single, fine spines basally; external face longitudinally convex, with sparse and fine punctures, glabrous; ventral margin sharp and finely serrate, with three strong equidistant spines; internal face finely and sparsely punctate, smooth, apex sharply and deeply truncate interiorly near tarsal articulation. Tarsomeres dorsally glabrous and impunctate, ventrally with sparse, short setae; metatarsomeres ventrally with a strongly serrate ridge, first metatarsomere little shorter than following two tarsomeres combined and one third of its length longer than dorsal tibial spur. Protibia moderately long, bidentate, protarsal claws symmetrical.

Aedeagus: Fig. 1E–G.

Diagnosis. The new species differs from all other Himalayan *Gynaecoserica* Brenske, 1896 species by the shiny body surface and the short antennal club. In external morphology it is quite similar to *G. compacta* Ahrens & Fabrizi, 2009 differing, however, in the wide lateral process of phallobasis (lateral view) and the shorter parameres.

Variation. Female: Length: 5.1 mm, length of elytra: 3.8 mm, width: 3.1 mm. Antennal club composed of three antennomeres, shorter than remaining antennomeres combined. Eyes as large as in male.

Etymology. The new species is named after its collector, Han Yinheng.

***Gynaecoserica yigongensis* Liu & Ahrens sp. n.**

Type material examined. Holotype ♂ [China] "Yigong, Xizang, 11.VI.1978, leg. Li Fasheng" (CAU). Paratype: 1 ♀ [China] "Yigong, Xizang, 11.VI.1978, leg. Li Fasheng" (CAU).

Description. Length: 6.2 mm, length of elytra: 5 mm, width: 3.7 mm. Body oblong and shiny, surface dark reddish brown, frons, abdomen and some spots on elytra dark

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brown, legs and antenna yellowish brown, dorsal surface nearly glabrous.

Labroclypeus subrectangular, widest at base, lateral margins in basal half subparallel, anterior angles broadly rounded, lateral border and ocular canthus producing a distinct obtuse angle, anterior margin weakly sinuate medially, margins weakly reflexed, surface weakly convex medially and moderately shiny, very coarsely and densely punctate, with a few long erect setae behind anterior margin; frontoclypeal suture moderately impressed and curved, smooth area anterior to eye narrow, 1.25 times as wide as long; ocular canthus short and slender, glabrous, without terminal seta. Frons shiny, with coarse and irregularly dense punctures. Eyes small, ratio of diameter/ interocular width: 0.54. Antenna with ten antennomeres, club in male with four antennomeres, as long as remaining antennomeres combined, first joint of club slightly shorter than club. Mentum elevated and flattened anteriorly.

Pronotum widest at base, lateral margins nearly straight, in basal half subparallel, evenly moderately convergent anteriorly, in anterior third slightly convex and more strongly convergent, anterior angles distinctly produced and sharp, posterior angles blunt, anterior margin convexly produced medially, with a fine marginal line, basal margin without marginal line; surface with dense and moderately coarse punctures, glabrous, midline not impressed; anterior and lateral borders sparsely setose; hypomeron carinate, basal margin of hypomeron not produced ventrally. Scutellum subtriangular, apex moderately rounded, with fine, dense punctures and minute setae, widely smooth medially.

Elytra oblong, widest at middle, striae moderately impressed, with fine and dense punctures; intervals weakly convex, with fine and dense punctures concentrated along striae, some punctures produce transverse wrinkles extending over more than one interval, impuctate portions slightly darker; epipleural edge moderately strong, ending at strongly rounded external apical angle of elytra, epipleura densely setose, apical border chitinous, without short microtrichomes.

Ventral surface dull, with large and dense punctures, nearly glabrous except a few erect setae on metasternal disc, metacoxa laterally with a few short adpressed setae. Abdominal sternites finely and densely punctate, with fine, short setae, each sternite with an indistinct transverse row of coarse punctures each bearing a short robust seta. Ultimate and penultimate abdominal sternites with a shallow, longitudinal median excavation. Mesosternum between mesocoxae as wide as mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.26. Pygidium weakly convex and entirely shiny, with fine and dense punctures, without smooth midline, with a few longer setae along apical margin.

Legs moderately robust and long; femora shiny, with two longitudinal rows of setae, finely and sparsely punctate; anterior margin of metafemur sharply carinate, without a submarginal serrate line, posterior margin weakly convex and glabrous, ventral part smooth and glabrous, only weakly widened in apical half and not serrate, dorsal margin finely serrate and with fine and short setae. Metatibia slender and moderately long, uniformly widened toward apex, ratio width/ length: 1/ 3.5, dorsal margin nearly longitudinally convex, indistinctly carinate only in apical third, with two groups of spines, basal group at one third, apical group at two thirds of metatibial length, basally with a few single, fine spines; external face longitudinally convex, with sparse and fine punctures, glabrous; ventral margin carinate and serrate, with four robust equidistant spines; internal face finely and sparsely punctate, smooth, apex sharply and deeply truncate interiorly near tarsal articulation. Tarsomeres dorsally glabrous and impunctate, ventrally with sparse, short setae; metatarsomeres ventrally with a strongly serrate ridge, first metatarsomere one third of its length longer than dorsal tibial spur, subsequent tarsomeres lacking in holotype. Protibia moderately long, bidentate, protarsal claws symmetrical.

Aedeagus: Fig. 1I–K.

Diagnosis. *Gynaecoserica yigongensis* sp. n. is in external shape similar to *G. compacta*. It differs by the longer and apically extended lateral apophysis of phallobasis as well as by the long, fused parameres being bent laterally (to the right). From *G. hani* sp. n. it may be distinguished by the slightly larger size, the shape of parameres as well as the longer lateral apophysis of phallobasis.

Etymology. The new species is named after the type locality, Yigong.

Variation. Length: 6.1–6.2 mm, length of elytra: 4.6–5.0 mm, width: 3.6–3.7 mm. Female: Antennal club composed of three antennomeres, shorter than remaining antennomeres combined.

Lasioserica beibeugaua Liu & Ahrens sp. n.

Type material examined. Holotype: ♂ [China] "Beibeng, Motuo, Xizang, 20.V.1983, 800m, 850m, 800–900m, leg. Han Yinheng" (IZAS). Paratypes: 1 ♂ [China] "Beibeng, Motuo, Xizang, 27.V.1983, 800m, 850m, 800–900m, leg. Han Yinheng" (IZAS), 1 ♂ [China] "Beibeng, Motuo, Xizang, 29.V.1983, 800m, 850m, 800–900m, leg. Han Yinheng" (ZFMK).

Description. Length: 5.4 mm, length of elytra: 4.0 mm, width: 3.5 mm. Body oblong, dorsal surface dark brown,

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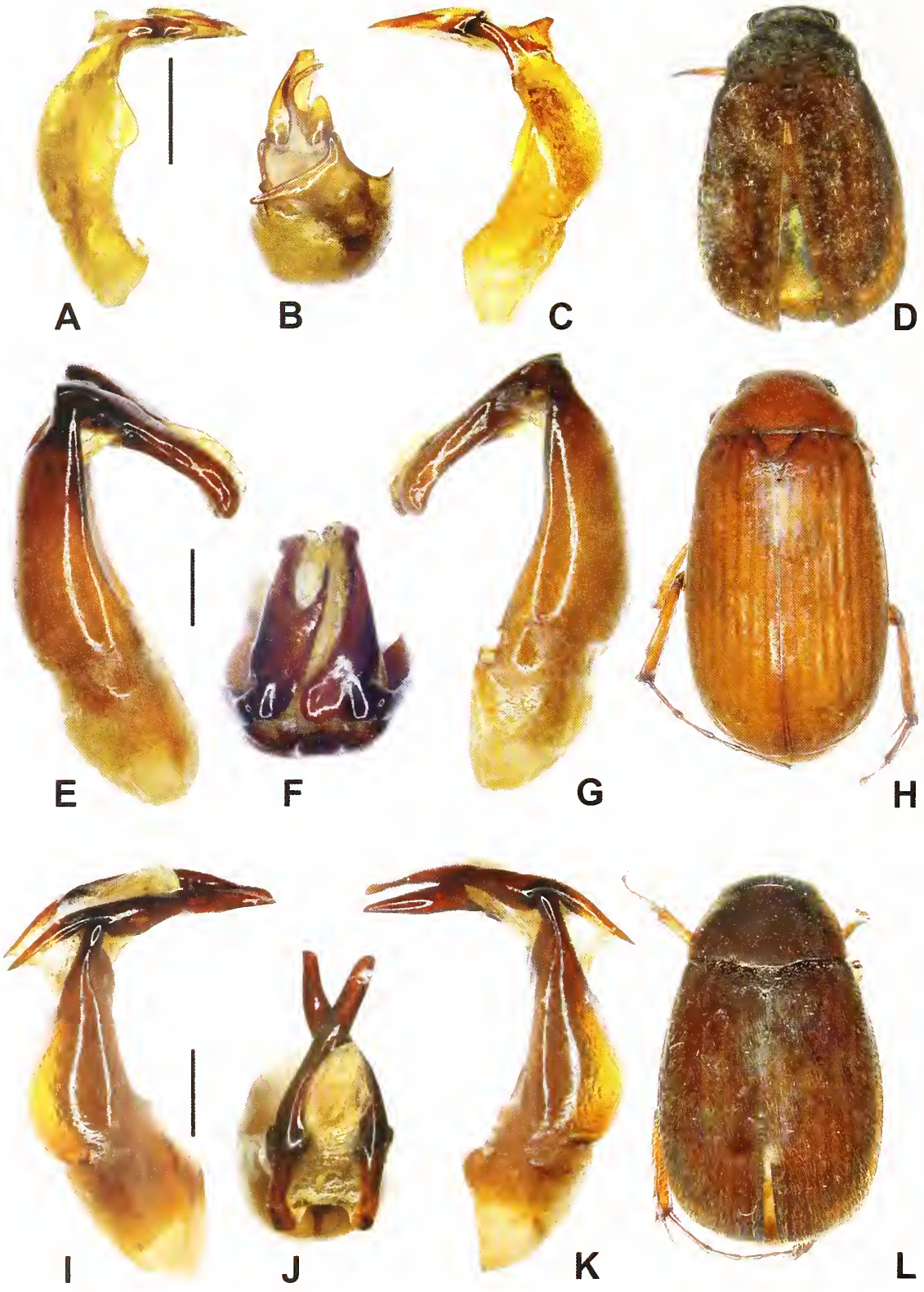

Fig. 2. A–D: *Lasioserica beibengana* Liu & Ahrens sp. n. (holotype), E–H: *Nepaloserica nielamuensis* Liu & Ahrens sp. n. (holotype), I–K: *Neoserica* (s.l.) *chayuensis* Liu & Ahrens sp. n. (holotype). A, E, I: Aedeagus, left side lateral view; C, G, K: Aedeagus, right side lateral view; B, F, J: Parameres, dorsal view; D, H, K: Habitus (not to scale). Scale: 0.5 mm.

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antenna and ventral surface brown, dorsal surface dull, pronotum and head with greenish shine, sparsely setose, with fine minute and white, scale-like setae on elytra and pronotum.

Labroclypeus subtrapezoidal, widest at base, lateral margins in basal half subparallel, anterioly strongly convex and strongly convergent from middle to broadly rounded anterior angles, lateral border and ocular canthus producing a distinct obtuse angle, anterior margin concavely sinuate, margins weakly reflexed; surface weakly convex medially and moderately shiny, finely and densely punctate, with a few long erect setae behind anterior margin; frontoclypeal suture weakly impressed and moderately curved, smooth area anterior to eye 1.5 times as wide as long; ocular canthus moderately long and narrow, finely and densely punctate, without terminal seta. Frons dull, finely and in part densely punctate. Eyes small, ratio of diameter/ interocular width: 0.5. Antenna with ten antennomeres, club in male with four antennomeres, 1.2 times as long as remaining antennomeres combined, first joint of club slightly shorter than club. Mentum elevated and flattened anteriorly.

Pronotum widest at base, lateral margins subparallel, nearly straight, distinctly and widely sinuate before posterior angles, moderately curved anteriorly and convergent to acute, distinctly produced anterior angles, posterior angles nearly right-angled, anterior margin nearly straight, with a fine marginal line, basal margin without marginal line; surface with dense and coarse punctures each bearing either an adpressed, minute seta or a moderately long, white scale, with a transverse impression behind middle; anterior and lateral borders sparsely setose; hypomeron carinate, basal margin of hypomeron weakly produced ventrally. Scutellum subtriangular, apex moderately rounded, with fine and dense punctures and moderate setae, smooth on basal midline.

Elytra oblong, widest shortly behind middle, striae moderately impressed, with fine and dense punctures; intervals moderately convex, with fine and dense punctures concentrated along striae, with sparse, short white scales or minute setae; epipleural edge moderately strong, ending at strongly rounded external apical angle of elytra, epipleura densely setose, apical border narrowly membraneous, with very short microtrichomes.

Ventral surface dull, with large and dense punctures, sparsely setose, metacoxa only laterally with a few fine, adpressed setae. Abdominal sternites finely and densely punctate and minutely setose, each sternite with a distinct transverse row of coarse punctures each bearing a short, robust seta. Penultimate abdominal sternite without tubercles but slightly transversely elevated medially. Mesosternum between mesocoxae as wide as mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.38. Pygidium moderately convex and dull, with coarse, dense punctures and fine, white setae, with wide smooth midline.

Legs moderately slender and long; femora dull on ventral face, with two longitudinal rows of setae, finely and sparsely punctate; anterior edge of metafemur acute, with an adjacent serrated line, ventrally weakly widened ventrally in apical half but not serrate, dorsally serrate. Tarsomeres glabrous, finely punctate dorsally, with sparse, short setae ventrally. Metatibia including tarsi missing in holotype. Protibia moderately long, bidentate. Protarsomeres missing in holotype. Female unknown.

Aedeagus: Fig. 2A–C.

Diagnosis. The shape of parameres is similar to those of *L. turaensis* Ahrens, 2000. It differs significantly by the at left side ventrally extended phallobasis, whose interior rim of dorsoapical median sinuation produces a sharply pointed dorsal process, which is unique trait among all other so far known *Lasioserica* Brenske, 1896 species.

Variation. Length: 5.0–5.6 mm, length of elytra: 3.8–3.9 mm, width: 3.0–3.2 mm. Protarsomeres short and robust, claws slightly asymmetrical, basal tooth of interior protarsal claw widened and bluntly truncate.

Etymology. The new species is named after the type locality, Beibeng.

Nepaloserica nielamuensis Liu & Ahrens sp. n.

Type material examined. Holotype ♂ "Zhangmu, Nielamu, Xizang, 23.IV.1974, 2250m, leg. Zhang Xuezhong" (IZAS). Paratypes: 3 ♂ "Zhangmu, Nielamu, Xizang, 23.IV.1974, 2250m, leg. Zhang Xuezhong" (IZAS, ZFMK), 1 ♂ "Zhangmu, Nielamu, Xizang, 10.V.1966, 2200m, leg. Wang Shuyong" (IZAS).

Description. Length: 9.9 mm, length of elytra: 8.2 mm, width: 5.2 mm. Body oblong, dorsal and ventral surface reddish brown and dull, antenna brown, except a few setae on head sparsely setose.

Labroclypeus narrow and nearly square, widest at base, lateral margins weakly convex and convergent from base to moderately rounded anterior angles, lateral border and ocular canthus producing a distinct obtuse angle, anterior margin moderately sinuate but strongly reflexed; surface nearly flat and shiny, finely and densely punctate, with a few long erect setae in coarser punctures anteriorly; frontoclypeal suture weakly impressed and moderately curved, smooth area anterior to eye 1.5 times as wide as long; ocular canthus long and slender, finely and densely punctate, with one to two terminal setae. Frons dull, finely and densely punctate, punctures vanish under dull toment, with a few long setae on posterior frons and beside eyes, otherwise only with minute setae. Eyes moderately large, ratio of diameter/ interocular width: 0.66. Antenna with ten

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antennomeres, club with seven antennomeres, 1.5 times as long as remaining antennomeres combined, first joint of club slightly shorter than club. Mentum elevated and flattened anteriorly.

Pronotum widest at middle, lateral margins in basal half subparallel, moderately curved and convergent anteriorly, anterior angles acute, distinctly produced, posterior angles blunt, anterior margin weakly produced medially, with a fine marginal line, basal margin without marginal line; surface with dense and coarse punctures bearing often a minute, adpressed seta; anterior and lateral borders sparsely setose; hypomeron carinate, basal margin of hypomeron not produced. Scutellum subtriangular, apex moderately rounded, with coarse and dense punctures.

Elytra oblong, widest at posterior third, striae distinctly impressed, with fine and dense punctures; intervals moderately convex, with fine and dense punctures concentrated along striae, glabrous exeept minute setae and a few short setae on lateral intervals; epipleural edge moderately strong, ending at strongly rounded external apical angle of elytra, epipleura densely setose, apical border membraneous, with a fine rim of short microtrichomes.

Ventral surface with large and dense punctures, sparsely setose, on metasternum with moderately dense and long setae; metacoxa only laterally with a few fine adpressed setae. Abdominal sternites finely and densely punctate, with fine, short setae medially on basal sternites and minute ones only laterally on other sternites, each sternite with a distinct transverse row of coarse punctures each bearing a short robust seta, abdominal sternites without any elevation. Mesosternum between mesocoxae as wide as mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.51. Pygidium moderately evenly convex, with coarse and dense punctures and a few moderately long setae on apical half; without smooth midline.

Legs slender and long; femora with two longitudinal rows of setae, finely and sparsely punctate; anterior edge of metafemur acute with an adjacent serrated line, ventrally weakly widened ventrally in apical half but not serrate, dorsally serrate. Metatibia moderately wide, widened at base, ratio width/ length: 1/3.9, dorsal margin sharply carinate, with two groups of spines, basal group at one third, apical one at three quarters of metatibial length, with a few single spines basally; lateral face longitudinally convex, with very sparse and fine punctures, along the middle nearly impunctate, ventral margin serrate, with three robust equidistant spines; medial face impunctate and smooth, apex interiorly near tarsal articulation shallowly concavely truncate. Tarsomeres glabrous and finely punctate dorsally, with sparse, short setae ventrally, metatarsomeres with a serrated ridge ventrally, and a sharp carina immediately beside it, first metatarsomere slightly shorter than following two tarsomeres combined and slightly longer than the dorsal tibial spur. Protibia short, bidentate, protarsal claws broken. Female unknown.

Aedeagus: Fig. 2 E–G.

Diagnosis. The new species is in shape of parameres rather similar to *N. procera procera* Frey, 1965 and *N. procera rufescens* Frey, 1965. From both it differs by the setose frons, the lack of elevations on penultimate sternites, as well as the broadly inserted basal lobe of right paramere, which is over half of its length fused with the paramere.

Etymology. The new species is named after the type locality, Nielamu.

Variation. Length: 9.3–11.3 mm, length of elytra: 7.4–8.8 mm, width: 5.3–5.9 mm. Protarsal claws symmetrical, basal tooth of inner claw sharply truncate at apex.

Neoserica (s.l.) *chayuensis* Liu & Ahrens sp. n.

Type material examined. Holotype ♂ [China] "Xiachayu, Chayu, Xizang, 12–13.VII.2005, leg. Shi Aimin" (HBUM). Paratypes: 1 ♀ [China] "Xiachayu, Chayu, Xizang, 12–13.VII.2005, leg. Shi Aimin" (HBUM), 2 ♂ [China] "Xiachayu, Chayu, Xizang, 15.VII.2005, leg. Shi Aimin" (HBUM, ZFMK).

Diagnosis. Length: 8.9 mm, length of elytra: 6.8 mm, width: 5.4 mm. Body oval, dorsal and ventral surface dull and dark brown, legs reddish brown, antenna yellow, dorsal surface with yellowish, short and fine, dense setae.

Labroclypeus trapezoidal, widest at base, lateral margins moderately convex and convergent from base to broadly rounded anterior angles, anterior margin weakly sinuate and moderately reflexed, lateral border and ocular canthus producing a distinct obtuse angle, surface flat and shiny, at base dull, finely and densely punctate, with numerous long, erect setae; frontoclypeal suture weakly incised and moderately curved, smooth area anterior to eye 1.5 times as wide as long; ocular canthus moderately long and slender, impunctate, with one or two terminal setae. Frons finely and densely punctate, completely dull, with dense and long erect setae. Eyes small, ratio of diameter/ interocular width: 0.56. Antenna with ten antennomeres, club in male with six antennomeres, as long as remaining antennomeres combined, first joint of club slightly shorter than club. Mentum elevated and flattened anteriorly.

Pronotum widest at base, lateral margins weakly curved and evenly convergent anteriorly, anterior angles acute, moderately produced, posterior angles wekaly rounded, anterior margin moderately convex, with distinct and fine marginal line, basal margin without marginal line; surface with dense and coarse punctures each bearing a yellow, semi-ereet, short seta being bent slight posteriorly, disc without any impression; anterior and lateral bor-

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ders sparsely setose, setae slightly longer than those of the disc; hypomeron carinate, basal margin of hypomeron not produced. Scutellum subtriangular, apex moderately rounded, with fine and dense punctures and fine setae.

Elytra oblong, widest shortly behind middle, striae weakly impressed, finely and densely punctate; intervals weakly convex, with evenly distributed, fine and dense punctures, each bearing a fine, semi-erect, yellow seta, odd intervals with a few longer, erect setae; epipleural edge moderately strong, ending at strongly rounded external apical angle of elytra, epipleura densely setose, apical border finely membraneous, with a fine rim of very short microtrichomes.

Ventral surface dull, with large, dense punctures and dense, sparse setae, metacoxa glabrous, with a few robust setae laterally only. Abdominal sternites finely and densely punctate, with fine, dense, short setae, each sternite with a distinct transverse row of coarse punctures each bearing a short robust seta. Mesosternum between mesocoxae as wide as mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.67. Pygidium weakly convex, with coarse, dense punctures and shorter and longer, fine setae, without smooth midline.

Legs moderately slender and long, moderately shiny, femora with fine and dense punctures and sparsely setose; anterior edge of metafemur acute, lacking an adjacent serrated line, ventral posterior margin weakly convex, weakly widened ventrally in apical half but not serrate, with a few fine setae, dorsal posterior margin serrate, with a few fine setae. Metatibia long and moderately wide, widest at apex, ratio width/ length: 1/ 4.2, dorsal margin sharply carinate, with two groups of spines, basal group shortly before middle, apical one shortly behind three quarters of metatibial length, with a few single spines basally on a short and blunt longitudinal elevation; lateral face longitudinally convex, with sparse and large, shallow punctures; ventral margin serrate, with three nearly equidistant robust setae; medial face impunctate and smooth, apex shallowly sinuate interiorly near tarsal articulation. Tarsomeres glabrous and finely and superficially punctate dorsally, with sparse, short setae ventrally, metatarsomeres with a strongly serrated ridge ventrally and a fine longitudinal carina immediately beside it, first metatarsomere slightly longer than following two tarsomeres combined and one third of its length longer than dorsal tibial spur. Protibia short, bidentate, protarsal claws symmetrical.

Aedeagus: Fig. 2I–K.

Diagnosis. The new species resembles in external and genital morphology to *Neoserica barberi* (Sharp, 1903) from southern India; it shares the subsymmetrical male genitalia, the shape of labroclypeus and legs, as well as the configuration of antennal club. From all species of the *N. barberi* group the new species differs by the dense pilosity of the dorsal body surface, as well as by the basal lobe present at each paramere.

Variation. Length: 8.9–10.5 mm, length of elytra: 6.8–8 mm, width: 5.4–6.6 mm. Female. Eyes smaller, ratio of diameter/ interocular width: 0.51, antennal club composed of five antennomeres, first joint of club subequal to one sixth of club length.

Etymology. The new species is named after the type locality, Chayu.

Remarks. Head and pronotum of one paratype ("Xiachayu, Chayu, Xizang, 15.VII.2005, leg. Shi Aimin") are missing.

Neoserica (s.l.) *xizangensis* Liu & Ahrens sp. n.

Type material examined. Holotype: ♂ [China] "Langcun, Lang County, Xizang, 8.VI.1986, 3080m, No. 581" (IZAS). Paratype: 1 ♂ [China] "Langxian County, Xizang, 5.VII.1981, leg. Chen Tailu" (ZFMK).

Description. Length: 8.0 mm, length of elytra: 5.8 mm, width: 4.0 mm. Body oblong, including legs yellowish brown, head slightly darker, antenna yellow, dorsal surface shiny, nearly glabrous.

Labroclypeus trapezoidal, widest at base, lateral margins moderately convex and convergent from base to moderately rounded anterior angles, anterior margin weakly sinuate medially, margins moderately reflexed, lateral margin and ocular canthus producing a distinct obtuse angle; surface flat, coarsely and very densely punctate, distance between punctures less their diameter, with a few short setae behind anterior margin; frontoclypeal suture weakly impressed and moderately curved, smooth area anterior to eye twice as wide as long; ocular canthus moderately long, finely and densely punctate, without terminal seta. Frons densely and coarsely punctate, entirely glabrous. Eyes moderately large, ratio of diameter/ interocular width: 0.69. Antenna with ten antennomeres, club in male with four antennomeres, as long as remaining antennomeres combined, first joint of club slightly shorter than club. Mentum elevated and flattened anteriorly.

Pronotum widest at middle, lateral margins weakly but evenly curved and convergent anteriorly and posteriorly, anterior angles right-angled, weakly produced, posterior angles blunt, anterior margin convexly produced medially, with distinct marginal line, basal margin without marginal line; surface with very dense and coarse punctures, without impressions; anterior and lateral borders sparsely setose; hypomeron only medially slightly carinate, carina completely reduced laterally, basal margin of hypomeron not produced. Scutellum subtriangular, apex

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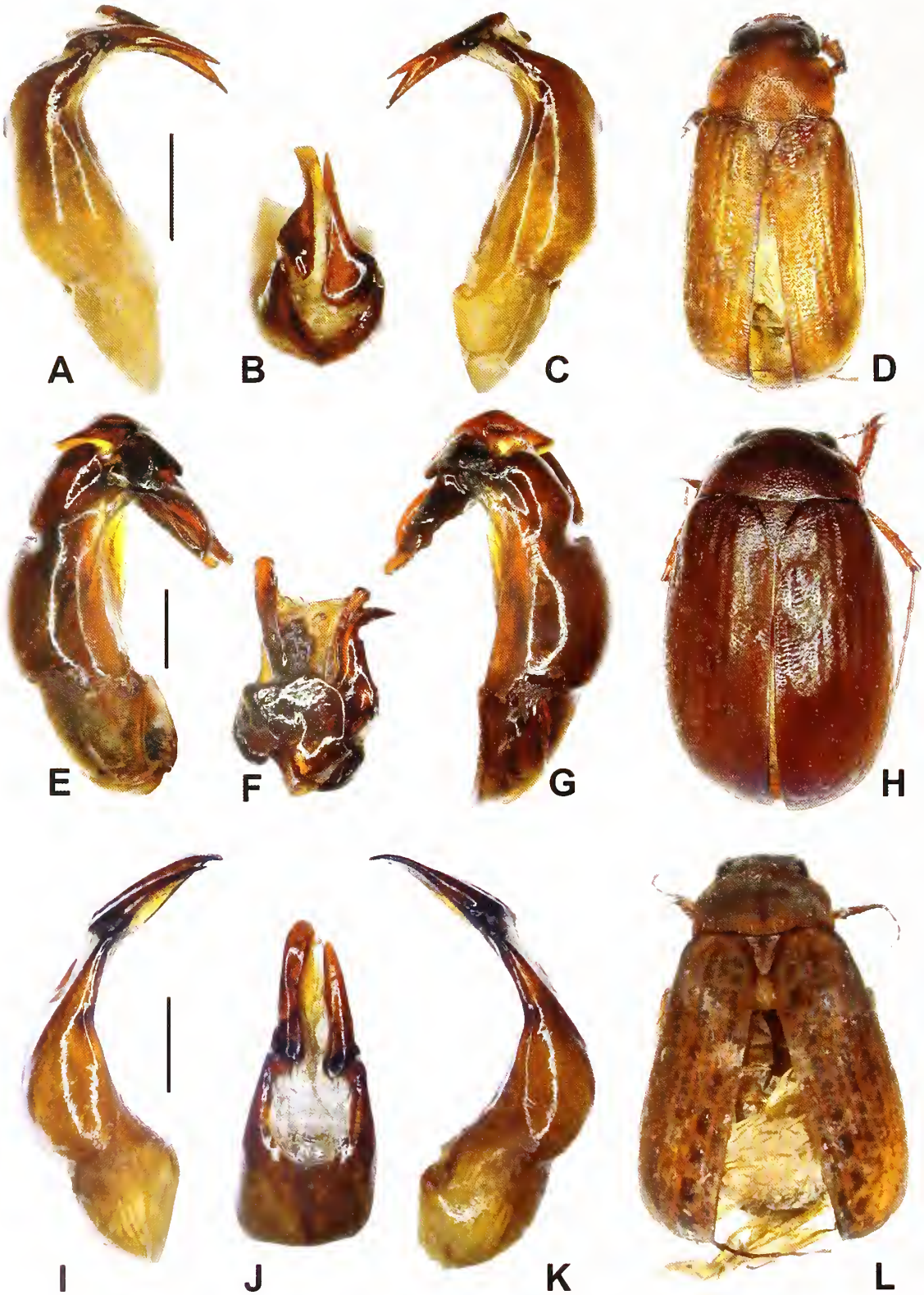

Fig. 3. A–D: *Neoserica (s.l.) xizangensis* Liu & Ahrens sp. n. (holotype), E–H: *Serica* (s.l.) *fashengi* Liu & Ahrens sp. n. (holotype), I–K: *S.* (s.l.) *yadongensis* Liu & Ahrens sp. n. (holotype). A, E, I: Aedeagus, left side lateral view; C, G, K: Aedeagus, right side lateral view; B, F, J: Parameres, dorsal view; D, H, K: Habitus (not to scale). Scale: 0.5 mm.

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moderately rounded, with coarse and dense punctures, glabrous.

Elytra oblong, widest at middle, striae weakly impressed, with fine and dense punctures; intervals weakly convex, with fine and dense punctures concentrated along striae, punctures with very minute setae, odd intervals with a few short yellow setae; epipleural edge robust, ending at strongly rounded external apical angle of elytra, epipleura densely setose, apical border chitinous, without short microtrichomes.

Ventral surface dull or weakly shiny, with large and dense punctures, sparsely setose except on metasternal disc. Mesosternum between mesocoxae as wide as mesofemur, with numerous strong setae on an indistinct semicircular carina. Ratio of length of metepisternum/ metacoxa: 1/ 1.27. Abdominal sternites finely and densely punctate, with fine, moderately dense setae on basal sternites, otherwise sparsely setose, each sternite with an indistinct transverse row of coarse punctures each bearing a short robust seta. Pygidium weakly convex and shiny, with fine, moderately dense punctures and fine setae, without smooth midline.

Legs long and slender, shiny, femora finely and sparsely punctate, sparsely setose; anterior edge of metafemur acute, lacking an adjacent serrated line, posterior ventral margin weakly convex, weakly widened ventrally in apical half but not serrate, posterior dorsal margin smooth, densely and shortly setose. Metatibia slender and very long, widest at apex, ratio width/ length: 1/ 6, dorsal margin longitudinally convex, not carinate, with two groups of spines, basal group at one quarter, apical one at two thirds of metatibial length, with a few single spines basally; lateral face longitudinally convex, with dense and coarse, longitudinally impressed punctures, glabrous; ventral edge carinate and finely serrate, with four equidistant robust spines, between each of them with a single short seta; medial face densely punctate and with long, dense setae, apex sharply truncate interiorly near tarsal articulation. Tarsomeres glabrous and finely punctate dorsally, with moderately dense, short setae ventrally; metatarsomeres with a strongly serrated ridge ventrally and a fine longitudinal carina immediately beside it, first metatarsomere slightly longer than following tarsomere and as long as dorsal tibial spur. Protibia long, bidentate, protarsomeres missing in holotype.

Aedeagus: Fig. 3A–C.

Diagnosis. At the moment it is difficult to nominate a closer relative of this new species. The reduced carina of hypomeron is found in Asia only in *Tetraserica* Ahrens, 2004 and *Serica* (s. str.) MacLeay, 1819 [from whose *N. xizangensis* differs in shape of aedeagus], while the shape of legs resemble somewhat those of *Sericania* Motschulsky, 1860, however, parameres are simple and do not have basal lobes as all other *Sericania* species.

Etymology. The new species is named after its occurrence in Xizang.

Variation. Length: 7.3–8.0 mm, length of elytra: 5.4–5.8 mm, width: 3.5–4.0 mm. Protarsomeres long and slender, claws symmetrical, basal teeth of protarsal claws sharply pointed.

Serica (s.l.) *fashengi* Liu & Ahrens sp. n.

Type material examined. Holotype: ♂ [China] "Yigong, Xizang, 29.VII.1978, 2300m, leg. Li Fasheng" (CAU). Paratypes: 1 ♂ [China] "Yigong, Xizang, 25.VII.1976, 2050m, leg. Li Fasheng" (ZFMK).

Description. Length: 9.2 mm, length of elytra: 7.7 mm, width: 5.6 mm. Body oblong-oval including legs dark reddish brown, dull, antenna yellowish brown, dorsal surface nearly glabrous, head and pronotum moderately shiny.

Labroclypeus subtrapezoidal, widest at base, lateral margins nearly straight and strongly convergent to broadly rounded anterior angles, anterior margin weakly sinuate, margins weakly reflexed, lateral border and ocular canthus producing a distinct obtuse angle, surface flat, coarsely and very densely punctate, without setae; frontoclypeal suture weakly impressed and moderately curved, smooth area anterior to eye1.5 times as wide as long; ocular canthus short and wide, finely and densely punctate, with a single, long terminal seta. Frons dull, coarsely and very densely punctate, with a few long setae beside eyes. Eyes moderately large, ratio of diameter/ interocular width: 0.66. Antenna with nine antennomeres, club with three antennomeres, 5 times as long as remaining antennomeres combined, club strongly reflexed. Mentum elevated and flattened anteriorly.

Pronotum widest at base, lateral margins nearly straight and evenly convergent anteriorly, in anterior third moderately curved and more strongly convergent, anterior angles acute, distinctly produced, posterior angles moderately rounded, anterior margin weakly convex medially, with a fine marginal line, basal margin without marginal line; surface with dense and coarse punctures, glabrous, without impressions; anterior and lateral borders sparsely setose; hypomeron carinate, basal margin of hypomeron not produced. Scutellum subtriangular, apex moderately rounded, with dense and coarse punctures, glabrous.

Elytra oblong, widest at middle, striae weakly impressed, with fine and dense punctures; intervals weakly convex, with fine and dense punctures concentrated along striae, except a few minute setae on lateral intervals glabrous; epipleural edge strong, ending at strongly rounded external apical angle of elytra, epipleura dense-

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ly setose, apical border membraneous, with short microtrichomes.

Ventral surface with large and dense punctures, except a few erect setae on metasternal disc nearly glabrous; metacoxa only laterally with a few robust, adpressed setae. Mesosternum between mesocoxae as wide as mesofemur, with numerous strong setae on an indistinct semicircular carina. Ratio of length of metepisternum/ metacoxa: 1/ 1.35. Abdominal sternites finely and densely punctate, nearly glabrous, each sternite with a distinct transverse row of coarse punctures each bearing a short robust seta. Pygidium weakly convex, with fine, dense punctures and a few fine setae along apical margin, without smooth midline.

Legs moderately long; femora with two longitudinal rows of setae, finely and sparsely punctate; anterior edge of metafemur acute with an adjacent, but partly interrupted serrated line, posterior ventral margin nearly straight, weakly widened in apical half and not serrate, posterior dorsal margin indistinctly serrate, densely setose. Metatibia moderately wide and long, slightly widened behind middle, ratio width/ length: 1/ 3.7, dorsal margin weakly carinate, with two groups of spines, basal group shortly before middle, apical one at three quarters of metatibial length, with a few single setae in serrated punctures basally; lateral face longitudinally convex, with fine and sparse punctures; ventral margin serrate; medial face impunctate and smooth, apex sharply truncate interiorly near tarsal articulation. Tarsomeres glabrous and impunctate dorsally, with sparse, short setae ventrally, metatarsomeres with a strongly serrated ridge ventrally, and longitudinal carina immediately beside it, first metatarsomere as long as following two tarsomeres combined and one third of its length longer than tibial spur. Protibia moderately long, bidentate, external edge smooth, claws symmetrical.

Aedeagus: Fig. 3 E–G.

Diagnosis. The new species belongs to the *Serica segregata* Arrow, 1946 group. It differs from *S. falcifera* Ahrens & Fabrizi, 2009 by the wider basal lobe of the right paramere, the sharply hooked dorsal lobe of left paramere, and the longer antennal club. It is hard to say with a single known specimen whether also the number of antennomeres constitute a species-specific diagnostic feature to distinguish from *S. segregata* and *falcifera* (both having an antenna composed of ten antennomeres instead of nine).

Etymology. The new species is named after the collector of the species, Li Fasheng.

Variation. Length: 9.2–10 mm, length of elytra: 7.5–7.7 mm, width: 5.3–5.6 mm.

***Serica* (s.l.) *yadongensis* Liu & Ahrens sp. n.**

Type material examined. Holotype: ♂ [China] "Yadong, Xizang, 1.VII.2004, leg. Ba Yibin, Shi Aimin" (HBUM). Paratype: 1 ♂ [China] "Xiasima, Yadong, Xizang, 14.VI.1983, leg. Wang Jia, Ci Ren, No.96-2" (IZAS).

Description. Length: 10 mm, length of elytra: 7.4 mm, width: 4.6 mm. Body oblong, dark reddish brown, head dark brown, antenna yellowish brown, dorsal surface dull, elytra with irregular dark spots; head and pronotum with long erect setae, elytra with minute to short white adpressed setae.

Labroclypeus narrowly subtrapezoidal, widest at base, lateral margins moderately convergent from base to moderately rounded anterior angles, anterior margin weakly sinuate, margins strongly reflexed, lateral border and ocular canthus producing a distinct obtuse angle; surface flat and moderately shiny, very coarsely and densely punctate, larger punctures each bearing a long erect setae interspersed with fine, glabrous punctures; frontoclypeal suture moderately impressed and curved, smooth area anterior to eye 1.5 times as wide as long; ocular canthus moderate long and robust, finely and densely punctate, with a long terminal seta. Frons dull, finely and densely punctate, with numerous long, erect setae. Eyes moderately large, ratio of diameter/ interocular width: 0.7. Antenna with ten antennomeres, club with three antennomeres, 1.5 times as long as remaining antennomeres combined, club slightly reflexed. Mentum elevated and flattened anteriorly.

Pronotum widest at base, lateral margins in basal half subparallel and slightly concavely sinuate, moderately curved and strongly convergent in anterior third, anterior angles bluntly rounded, moderately produced, anterior margin nearly straight, with a fine marginal line, posterior angles moderately round, basal margin without marginal line; surface with dense and fine punctures, midline impunctate, with several long erect setae bent posteriorly, otherwise laterally with short, white or minute setae; anterior and lateral borders densely setose; hypomeron carinate, basal margin of hypomeron not produced. Scutellum subtriangular, apex moderately rounded, with fine and very dense punctures, glabrous, impunctate on midline.

Elytra oblong, widest at middle, striae moderately impressed, with fine and dense punctures, reddish brown; intervals moderately convex, second interval posteriorly strongly widened, intervals with irregular, fine and dense punctures, with fine, minute or short, scale-like, adpressed setae concentrated along striae, punctation partly interrupted by large and dark impunctate spots; epipleural edge moderately strong, ending at strongly rounded external apical angle of elytra, epipleura densely setose, apical border membraneous, with a very fine rim of short microtrichomes.

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Ventral surface with large and dense punctures, densely setose; metacoxa glabrous, only laterally with a few fine adpressed setae. Mesosternum between mesocoxae as wide as mesofemur. Ratio of length of metepisternum/ metacoxa: 1/ 1.5. Abdominal sternites finely and moderately densely punctate, punctures with minute setae, each sternite with an indistinct transverse row of coarse punctures each bearing a short, robust seta. Pygidium strongly convex, with coarse, moderately dense punctures and fine, long setae, midline smooth.

Legs slender and long; femora with two longitudinal rows of setae, finely and sparsely punctate; anterior edge of shiny metafemur acute, without an adjacent serrated line, ventral posterior margin nearly straight, weakly widened in apical half ventrally, not serrate, dorsal posterior margin serrate and densely setose. Metatibia slender and long, abruptly widened at apex, ratio width/ length: 1/ 4.2, dorsal margin longitudinally convex, with two groups of spines, basal group at one third, apical one at three quarters of metatibial length, with a few single setae basally; lateral face longitudinally convex, with sparse and moderately coarse punctures, some of them longitudinally impressed, glabrous; ventral margin serrate, with four equidistant spines; medial face impunctate and smooth, apex sharply truncate interiorly near tarsal articulation. Tarsomeres glabrous and impunctate dorsally, with sparse, short setae ventrally, metatarsomeres with a strongly serrated ridge ventrally and a longitudinal carina immediately beside it; first metatarsomere distinctly shorter than following two tarsomeres combined and twice as long as dorsal tibial spur. Protibia moderately long, bidentate, external edge smooth, claws symmetrical. Female unknown.

Aedeagus: Fig. 3I–K.

Diagnosis. The new species differs from *Serica erectosetosa* Ahrens, 1999 by having nearly straight parameres (lateral view), and from all other species of *S. erectosetosa* group by having long erect setae on head and pronotum, parameres are more strongly asymmetric as in *S. karnaliensis* Ahrens, 1999.

Etymology. The new species is named after the type locality, Yadong.

Variation. Length: 9.0–10.0 mm, length of elytra: 7.0–7.4 mm, width: 4.6–5.1 mm.

ADDITIONAL MATERIAL

***Serica* (s. str.) *guidoi* Ahrens, 1999**
Additional material examined. 1 ♂ "Zhangmukou, Nielamu, Xizang, 12.V.1974, 2250m, leg. Zhang Xuezhong" (IZAS).

***Serica* (s. str.) *khajiaris* Mittal, 1988**
Additional material examined. 2 ♂ "Yigong, Bomi, Xizang, 14,22.VIII.1983, 2300m, leg. Han Yinheng" (IZAS).

***Serica* (s. str.) *kingdoni* Ahrens, 1999**
Additional material examined. 1 ♀ "Qiujiaba, Wen County, Gansu, 22.VII.1999, 2350m, leg. Yao Jian" (IZAS), 3 ♀ "Qiujiaba, Wen County, Gansu, 21.VII.1999, 2350m, leg. He Tongli" (IZAS), 1 ♂ "Hailuo Gou, Moxi, Luding, Sichuan, 9.VIII.2004, 3000m, leg. Wan Xia, Zhang Yong" (IZAS), 1 ♀ "Wolongguan Gou, Wolongzhen, Sichuan, 20.VII.2004, 2150m, leg. Zhang Yong" (IZAS), 1 ♂ "Yaojiaping, Lushui, Yunnan, 2.VI.1981, 2500m, light trap, leg. Wang Shuyong" (IZAS), 1 ♂ "Sanshenggou, Wolong, Sichuan, 8.VIII.1983, 2500m, leg. Niu Chunlai" (IZAS), 1 ♂ "Chayu, Xizang, 22.VII.2009, leg. Ren Guodong etc." (HBUM), 1 ♂ "Hailuogou, Moxi, Luding, Sichuan, 8.VIII.2004, 3000m, leg. Wan Xia" (IZAS).

***Serica* (s. str.) *montrouili* Ahrens, 2005**
Additional material examined. 1 ♂ "Maxionggou, Xiangcheng, Sichuan, 25.VI.1982, 3800m, leg. Wang Shuyong" (IZAS), 1 ♀ "Haizigou, Mts. Siguniangshan, Sichuan, 29.VII.2004, 3400–3860m, leg. Bai Ming" (IZAS), 1 ♀ "Shuangqiaogou, Mts. Siguniangshan, Sichuan, 28.VII.2004, 3840m, leg. Bai Ming" (IZAS), 1 ♂ "Jiangda, Xizang, 28.VII.1976, 3400m, leg. Han Yinheng" (IZAS), 1 ♀ "Haitong, Mangkang, Xizang, 7,8.VIII.1983, 2950-3050m, leg. Lin Zai" (IZAS), 1 ♂ "Gelong, Yushu, Qinghai, 10,12.VII.1964, 3700m, leg. Wang Shuyong" (IZAS), 1 ♂ "Zhongreniao, Xiangcheng, Sichuan, 17.VII.1982, 4100m, leg. Zhang Xuezhong" (IZAS).

***Serica* (s. str.) *nepalensis* (Frey, 1969)**
Additional material examined. 1 ♂ "Zhangmu, Nielamu, 21.IV.1974, 2250m, leg. Zhang Xuezhong" (IZAS), 1 ♀ "Jitang Youxi, Chaya, Xizang, 16.VIII.1976, leg. Han Yinheng" (IZAS), 1 ♂ "Youyi Bridge, Nielamu, Xizang, 21.IV.1974, 1668m, leg. Zhang Xuezhong" (IZAS), 1 ♀ "Zhangmu, Nielamu, Xizang, 21.IV.1974, leg. Zhang Xuezhong" (IZAS), 1 ♂, 1 ♀ "Zhangmukouan, Xizang, 28.VI.1975, 2250m, leg. Zhang Xuezhong" (IZAS).

***Serica* (s. str.) *thibetana* Brenske, 1897**
Additional material examined. 1 ♂ "Youyi Brigde, Nielamu, Xizang, 6.V.1974, 1680m, light trap, leg. Zhang Xuezhong" (IZAS), 1 ♂ "Yadong, Xizang, 29.VII.1980, 2700m, light trap, leg. Li Aihua" (IZAS), 1 ♂ "Xiasima, Yadong, Xizang, 29.V.1983, leg. Wang Jia, Ci Ren, No. 98-3"(IZAS), 1 ♂ "Yadong, Xizang, 29.V.1983, 2700m, light trap, leg. Li Aihua" (IZAS).

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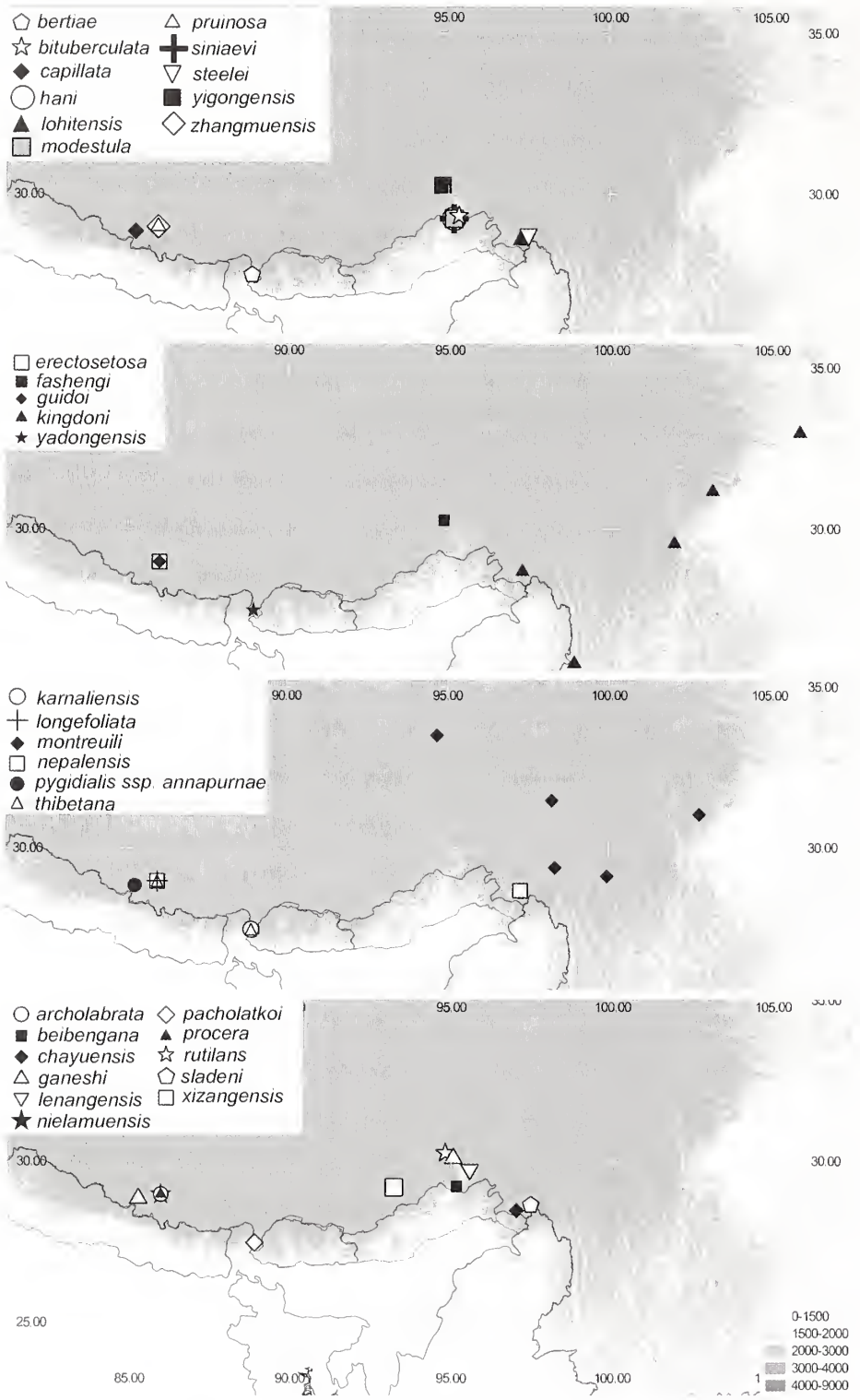

Fig. 4. Distribution and new records of: **A:** *Calloserica bertiae*, *C. capillata*, *C. zhangmuensis*, *Gynaecoserica hani*, *G. lohitensis*, *G. yigongensis*, *Maladera modestula*, *M. siniaevi*, *Microserica pruinosa*, *Mi. steelei*, *Pachyserica bituberculata*. **B:** *Serica* (s.l.) *erectosetosa*, *S.* (s.l.) *fashengi*, *Serica* (s.str.) *guidoi*, *S.* (s.str.) *kingdoni*, *S.* (s.str.) *yadongensis*. **C:** *S.* (s.l.) *karnaliensis*, *S.* (s.str.) *montreuili*, *S.* (s.str.) *nepalensis*, *S.* (s.str.) *thibetana*, *Oxyserica longefoliata*, *O. pygidialis ssp. annapurnae*. **D:** *Lasioserica beibengana*, *L. pacholatkoi*, *Neoserica lenangensis*, *N. sladeni*, *N. chayuensis*, *N. rutilans*, *N. xizangensis*, *Nepaloserica archolabrata*, *Ne. ganeshi*, *Ne. nielamuensis*, *Ne. procera*.

***Serica* (s. l.) *karnaliensis* Ahrens, 1999**
Additional material examined. 1 ♀ "Yadong, Xizang, 1.VII.2004, leg. Ba Yibin, Shi Aimin" (HBUM).

***Serica* (s. l.) *erectosetosa* Ahrens, 1999**
Additional material examined. 1 ♂ "Zhangmu, Nielamu, Xizang, 12.V.1974, 2250m, leg. Zhang Xuezhong" (IZAS).

***Paclıyserica bituberculata* Ahrens, 2006**
Additional material examined. 1♂ "Motuo, Xizang, 14.VIII.2003, 1100m, leg. Ren Guodong"(HBUM), 1 ♂ "Maniweng, Motuo, Xizang, 28.VIII.1974, 930m, leg. Huang Fusheng" (IZAS).

***Calloserica bertiae* Ahrens, 2000**
Additional material examined. 1 ♂ "Xiasima, Yadong, Xizang, 8.VII.1983, leg. Wang Jia, Ci Ren" (IZAS).

***Calloserica capillata* Ahrens, 2005**
Additional material examined. 1 ♂ "Zhangmu, Xizang, 28,30.VI.1975, 2400m, leg. Huang Fusheng, Wang Ziqing" (IZAS), 1 ♂ "Xiao Jilong, Jilong, Xizang, 20,22.VII.1975, 2800m, leg. Huang Fusheng" (IZAS).

***Lasioserica* (s. l.) *pacholatkoi* Ahrens, 2000**
Additional material examined. 1 ♂ "Yadong, Xizang, 27.VIII.2003, 2900m, light trap, leg. Xue Huaijun, Wang Xinpu" (NKU).

***Neoserica* (s. l.) *lenangensis* Ahrens & Fabrizi, 2009**
Additional material examined. 1 ♂ "Bomi, Xizang, 3.IX.1982, 3050m, leg. Han Yinheng" (IZAS).

***Neoserica* (s. l.) *rutilaus* Ahrens & Fabrizi, 2009**
Additional material examined. 1 ♂, 1 ♀ "Yigong, Xizang, 11,15.VI.1978, 2300m, leg. Li Fasheng" (CAU).

***Neoserica* (s. l.) *sladeni* Ahrens, 2004**
Additional material examined. 1 ♂ "Sangjiu, Chayu, Xizang, 23.VI.1973, 3000m, leg. Huang Fusheng" (IZAS).

***Oxyserica longefoliata* (Frey, 1965)**
Additional material examined. 1 ♂ "Zhangmu, Xizang, 5–6.VII.2004, leg. Ba Yibin, Shi Aimin" (HBUM).

***Oxyserica pygidialis* ssp. *annapurnae* (Ahrens, 1995)**
Additional material examined. 2 ♂, 2 ♀ "Jilong District, Jilong County, Xizang, 19–20.VII.1975, 2800m, leg. Zhang Xuezhong" (IZAS), 1 ♂, 1 ♀ "Xiaojilong, Jilong, Xizang, 20.VII.1975, 2800m, leg. Huang Fusheng" (IZAS), 1 ♂ "Jilonggongshe, Xizang, 27.VII.1984, leg. Pu Qiongqiong" (IZAS).

***Gyuaecoserica lohitensis* Ahrens & Fabrizi, 2009**
Additional material examined. 1 ♂ "Chayu, Xizang, 16–17.VII.2005, leg. Shi Aimin" (HBUM).

***Microserica pruinosa* (Hope, 1831)**
Additional material examined. 1 ♂ "Youyiqiao, Nielamu, Xizang, 6.V.1974, 1680m, leg. Zhang Xuezhong" (IZAS).

***Microserica steelei* Ahrens, 2004**
Additional material examined. 1 ♂, 1 ♀ "Shajiao, Chayu, Xizang, 25.VI.1978, 1700m, leg. Li Fasheng" (CAU).

***Nepaloserica archolabrata* Ahrens & Sabatinelli, 1996**
Additional material examined. 1 ♂ "Youyi Bridge, Nielamu, Xizang, 7.V.1974, 1680m, leg. Zhang Xuezhong" (IZAS).

***Nepaloserica ganeshi* Ahrens, 1999**
Additional material examined. 2 ♂ "Jilong, Xizang, 11.VI.1978, 3150m, leg. Institute of Agricultural Sciences" (IZAS), 1 ♂ "Jilong Gongshe, Xizang, 16.VI.1984, leg. Yan Zhaoxing, Pu Qiongqiong" (IZAS), 1 ♂ "Tongmai, Jilong, Xizang, 25.VI.1984, leg. Yan Zhaoxing" (IZAS).

***Nepaloserica procera procera* Frey, 1965**
Additional material examined. 1 ♂ "Qu County, Zhangmu, Xizang, 6.VII.1975, 3400m, leg. Zhang Xuezhong" (IZAS), 2 ♂ "Quxiang, Zhangmu, Xizang, 6.VII.1975, 3300m, 3400m, leg. Huang Fusheng, Zhang Xuezhong" (IZAS), 1 ♂ "Jilong Gongshe, Jilong, Xizang, 22.V.1982, leg. Li Baoming, Wangjia, Daci" (IZAS).

***Maladera modestula* (Brenske, 1902)**
Additional material examined. 1♂ "Beibeng, Motuo, Xizang, 21.V.1983, 700–800m, leg. Han Yinheng" (IZAS), 1 ♀ "Beibeng, Motuo, Xizang, 25.V.1983, 850m, leg. Han Yinheng" (IZAS).

***Maladera siniaevi* Ahrens, 2004**
Additional material examined. 1 ex. "Beibeng, Motuo, Xizang, 29.V.1983, 800–900m, leg. Han Yinheng" (IZAS).

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Neotropical primates from the Cologne Zoo in the collections of the Zoologisches Forschungsmuseum Alexander Koenig: noteworthy specimens, taxonomic notes and general considerations

Gustav Peters [1], Tanja Haus [2,3] & Rainer Hutterer [1]

[1] *Department of Vertebrates, Zoologisches Forschungsmuseum Alexander Koenig, Adenauerallee 160, D-53113 Bonn, Germany; E-mail: g.peters@zfmk.de*

[2] *Primate Genetics Laboratory,* [3] *Cognitive Ethology Laboratory, German Primate Center, Leibniz Institute for Primate Research, Kellnerweg 4, D-37077 Goettingen, Germany; E-mail: THaus@dpz.eu*

Abstract. Cologne Zoo was a major place for the captive care of primates of the family Pitheciidae in the second half of the last century. Various species of the genera *Cacajao*, *Chiropotes* and *Pithecia*, which until then had a poor survival record in human care, lived at the Cologne Zoo for years. This offered the unique possibility to gather important information on their biology and care in captivity. Moreover several individuals were featured in a diverse array of technical publications and/or were mentioned in respective texts. However, at that time knowledge on the taxonomy of South American primates was still incomplete. New species and subspecies were named, some of which were kept in the zoo unnoticed. After their death Cologne Zoo donated specimens as vouchers to the Zoologisches Forschungsmuseum Alexander Koenig. We evaluate their species identity in the context of the ongoing debate on the taxonomy of these three genera and also address the potential importance of zoo specimens for the scientific study of taxonomic and biological questions. Furthermore, based on our data the status of *Chiropotes israelita* and *C. sagulatus* as valid species is questioned.

Key words. Primates, Pitheciidae, Neotropics, zoo biology, museum vouchers, taxonomy, identification.

INTRODUCTION

From the very beginning of the existence of zoological museums, menageries and zoos have been an important source of specimens for their collections, especially for exotic species (Jahn 1994; Landsberg 1994; Oppermann 1994). Compared to specimens collected in their natural distribution area (with appropriate documentation) those originating from captivity usually have shortcomings in respect of their informative value, significance as vouchers, and thus also for many research topics typically carried out in zoological museums. Although here is not the place to discuss this in detail, specimens in museum collections that come from a zoo can be important in various aspects. Here we address this issue exemplarily for a few Neotropical primate specimens in the mammal collections of the Zoologisches Forschungsmuseum Alexander Koenig, Bonn (ZFMK) that were donated by the Cologne Zoo after the animals had deceased. The present report is also a supplement to the catalogue of mammalian types and other important voucher specimens in the ZFMK (Hutterer & Peters 2010).

Two recent publications (Pauly 2010; Pagel & Spieß 2011) animated us to write the present report and to put forward some general considerations in this context. Pauly (2010) discussed the species determination of a primate individual that lived in Cologne Zoo between 1974 and 1992 in view of a recently published taxonomic reassessment of the black-headed uacari (*Cacajao melanocephalus*; Boubli et al. 2008). Pagel & Spieß (2011) provided a complete list of all mammal (sub-) species kept at Cologne Zoo since its opening in 1860 with contemporary and current scientific names. By discussing specific examples within a wider perspective we hope to increase awareness both in zoological museums and zoos that the lasting deposition of deceased zoo specimens in a zoological museum and their subsequent scientific curation is the most reasonable 'fate' for zoologically important/interesting specimens of such origin. Only in doing so their significance can be saved and their sustained scientific use warranted. The same issue was addressed by Gippoliti & Bruner (2007) and Gippoliti & Kitchener (2007) in particular.

BACKGROUND

Cologne Zoo was a major place for the captive care of primates of the family Pitheciidae (taxonomy as in Groves 2005) outside their natural range in South America for sev-

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eral decades in the second half of the last century (cf. Hick 1965b, 1966, 1968a, b, 1973, 1974; Hershkovitz 1985, 1987a, b). Various species of the genera *Cacajao*, *Chiropotes* and *Pithecia*, for which relatively little information was available at that time and which until then had a poor survival record in human care, lived at the zoo for years and important information on their biology and care in captivity was gathered and published (Hick 1965b, 1966, 1968a, b). Hershkovitz (1985: 17) named a new subspecies of bearded saki *Chiropotes satanas utahicki* after Ms. Uta Hick (subsequently and correctly, the name was changed to *utahickae*, following the International Code of Zoological Nomenclature; ICZN 1999), the then-curator of primates at Cologne Zoo. Hershkovitz (1985) did so to acknowledge her achievements in the captive care of Pitheciidae and of her major contributions to the knowledge of these primates. Photos of several live individuals of these three genera from Cologne Zoo were presented in technical publications and/or they were mentioned in their text (e.g. Hill 1960; Napier & Napier 1967; Mittermeier & Coimbra-Filho 1981; van Roosmalen et al. 1981; Hershkovitz 1985, 1987 a, b). At that time the taxonomy of *Cacajao*, *Chiropotes* and *Pithecia* was far from being settled (Hershkovitz 1985, 1987 a, b). In the context of the recent 'revival' of the debate on the taxonomy of *Chiropotes* (Boubli 2002; Silva-Jr. & Figueiredo 2002; Bonvicino et al. 2003; Veiga et al. 2008; Ferrari et al. 2013; Silva-Jr. et al. 2013), *Cacajao* (Boubli et al. 2008; Ferrari et al. 2013; Silva-Jr. et al. 2013) and *Pithecia* (Marsh 2004, 2006, 2014), some specimens of these taxa, which the ZFMK received from Cologne Zoo, regain significance. Unfortunately, the ZFMK received only a minor fraction of the individuals that lived in the Cologne Zoo between 1954 and 2005, and for none of these specimens verifiable data as to their geographic origin are available. Therefore statements with respect to agreement/disagreement of their characteristics with those reported for specimens from specific geographic areas are made conditionally. A revision of the genus *Pithecia* (Hershkovitz 1987b) includes a photo of a live individual of this genus from Cologne Zoo. Although it was not given to the ZFMK after its death, it will be addressed in the present report as well to indicate the potential importance of such zoo specimens for the scientific community.

MATERIAL AND METHODS

Our study is based on the voucher specimens of Neotropical primates deposited in the mammal collections of Zoologisches Forschungsmuseum Alexander Koenig (ZFMK_MAM). Species of *Cacajao*, *Chiropotes* and *Pithecia* that originated from Cologne Zoo were analysed in the context of published and unpublished zoo records and photographs made available by the zoo archivists R. Becker and W. Spieß. We are aware of the limited significance of photos in drawing fully substantiated conclusions as to the 'actual' colour in cases where (fur) colour characteristics are diagnostic criteria for the differentiation of taxa and will address this issue where relevant. The same applies to the fading and possible change of colours in long-term museum specimens, especially those on exhibit.

Nomenclature

English common names of taxa used in the present publication are those given in the primate chapter of Mammal Species of the World (Groves 2005). Some names coined in Ferrari et al. (2013) are in conflict with the taxonomic views expressed here. Vernacular names with adjective characterizations of the species' body coat colour are adopted with reservations because they imply that it is a diagnostic character. This can be delusive, though, as will be detailed below.

Molecular methods

DNA extraction, amplification and sequencing

To determine a questionable *Chiropotes* specimen from Cologne Zoo (ZFMK_MAM_2008.244), whose species affiliation could not be clearly determined based on external characters, we extracted DNA from a small piece of skin in the ancient DNA laboratory at York University following the protocol of Haus et al. (2013). We used 0.09 mg sample and incubated it for about 24h in 1.5 ml of a Guanidinium thiocyanate (GuSCN) buffer (5M GuSCN, 25 mM NaCl, 50 mM Tris, 20 mM EDTA, 1% Tween 20, 1% beta-mercaptoethanol), which was modified from Rohland et al. (2004). To purify the DNA we applied a combination of a batch-based silica and a column-based method according to Rohland & Hofreiter (2007) and Rohland et al. (2010). Finally we eluted the DNA in 50 µl TE buffer. To monitor for possible contamination we additionally performed a blank extraction without sample.

To compare our data with already published sequences of other *Chiropotes* taxa we amplified and sequenced a 390 bp long fragment of the cytochrome (cyt) *b* gene. Bonvicino et al. (2003) used a 372 base pair (bp) long fragment of the cyt *b* gene to distinguish between different species of *Chiropotes*. Accordingly, we amplified the same cyt *b* fragment using primers Cytb_fwTGATATGAAAAACCATCGTTG (modified from Bonvicino et al. 2001) and Cytb_rvACCTATAAATGCTGTAGCTAT in a 20 µl mix (3 U AmpliTaq Gold 360 (Applied Biosystems, Germany), 1x reaction buffer, 2 mM $MgCl_2$, 0.25 mM for each dNTP, 0.75 µM for each primer, and 0.1 mg/ml BSA) and following PCR conditions: 94°C for 10 min, followed by 60 cycles of 94°C for 30 s 62°C for 45 s, 72°C 45 s,

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and 72°C for 5 min. Due to the length of our amplified product (390 bp) and the usually high degradation of DNA retrieved from museum samples, the possibility that our sequence represents a putative nuclear insertion of mitochondrial DNA (numt) is low. To control for possible contamination with modern DNA, the PCR reaction was conducted with two PCR blanks (HPLC-purified water) in addition to the extraction blank. We ran the PCR product on a 1.5% agarose gel, and purified it with the Qiagen Gel Extraction Kit (Qiagen, Germany) after excision. Subsequently, forward and reverse sequences were run on an ABI 3130*xL* sequencer using the BigDye Terminator Cycle Sequencing Kit (Applied Biosystems, Germany) and respective primers. The *Chiropotes* sequence can be downloaded from GenBank (GenBank accession number: KF989492).

Phylogenetic analysis

To examine phylogenetic relationships we used sequences of six related taxa as outgroups (*Alonatta belzebul* AF289515, *Saimiri sciureus* U53582, *Callicebus personatus* AF289988, *Callicebus donacophilus* FJ85423, *Cacajao melanocephalus* AY226184, *Pithecia irrorata* AY226183) and further included all *Chiropotes* cyt *b* sequences available from GenBank: *Chiropotes albinasus*: KC757393; *C. utahickae*: AY226185, AY226186; *C. israelita*: AY226187-AY226190; *C. chiropotes/sagulatus*: FJ531667). We used the same *Chiropotes* sequences as in Bonvicino et al. (2003), except for *Chiropotes albinasus* (Finstermeier et al. 2013) and the cyt *b* gene of *C. chiropotes/ sagulatus* from Rio Trombetas east of Rio Branco (Figueiredo-Ready et al. 2013). All sequences were aligned using the program Mega 5.0 (Tamura et al. 2011). We also used Mega 5.0 to check for putative numts; we translated all sequences into amino acid sequences to detect possible unexpected stop codons in our alignment, which was not the case. Best fit nucleotide substitution models were estimated with jModeltest (Guindon & Gascuel 2003; Posada 2008) and chosen based on the Akaike Information Criterion (AIC). Correspondingly, we used the TrN+G model to reconstruct neighbor-joining (NJ; Mega 5.0, Tamura et al. 2011), maximum-likelihood (ML; Garli 2.0, Zwickl 2006; Paup*4b10, Swofford 1993) and Bayesian (MrBayes 3.1.2, Huelsenbeck et al. 2001, Ronquist & Huelsenbeck 2003) phylogenetic trees. For NJ and ML we used 1000 and 500 bootstrap replications, respectively. We applied 10 million generations for the Bayesian approach and sampled parameters every 10,000 generations; the first 25% of sampled trees and parameters were discarded as burn in. Phylogenetic trees were finally visualized and edited in FigTree1.4.0 (Rambaut 2008).

RESULTS & DISCUSSION

Cacajao Lesson, 1840

After the past argument on whether red and white uacaris are the same or different species (Napier & Napier 1967; Chiarelli 1972) had been provisionally settled (Hershkovitz 1972, 1987a), the genus was generally considered to include two species, the black-headed uacari *Cacajao melanocephalus* (Humboldt, 1811) (not 1812, as in Groves 2005), and the bald uacari *Cacajao calvus* (I. Geoffroy, 1847), the latter encompassing the white and the red form (Barnett & Brandon-Jones 1997; Groves 2001, 2005; Barnett 2005). More recently, based on genetic, morphological and ecological data Boubli et al. (2008) described two new species of black-headed uacari, *Cacajao hosomi* Boubli et al., 2008, and *Cacajao ayresi* Boubli et al., 2008. Moreover, they argued that *ouakary* (Spix, 1823) presents a junior synonym of *melanocephalus* according to the original description of pelage colour of both specimens, the uncertainty of the type locality of Humboldt's specimen of *melanocephalus* and to the now knowledge of the geographical distribution of different pelage patterns in this group. This taxonomic arrangement was not followed by Ferrari et al. (2010) and Silva-Jr. et al. (2013), who proposed to recognise three species *Cacajao calvus*, *C. melanocephalus* and *C. ouakary* (Ferrari et al. 2010), and additionally the newly described species *Cacajao ayresi* Boubli et al., 2008 (Silva-Jr. et al. 2013). However, since no published data exist to support findings of Ferrari, Silva-Jr. and colleagues, for now we will retain the taxonomy of Boubli et al. (2008). Their publication is also relevant for a specimen the ZFMK received from Cologne Zoo, which we will discuss below in more detail.

Cacajao melanocephalus (Humboldt, 1811) sensu lato – Black-headed uacari

According to the annual animal registers of Cologne Zoo (Spieß, pers. comm. 2011; Becker, pers. comm. 2011) two individuals were received in 1958 and one in 1959. All three individuals only lived for a short time and no more specific documentation for these specimens is left. Further, no material was transferred to a zoological museum or another scientific institution after their death. Therefore it is not possible to retroactively assess their actual species identity in the light of the recent publication of Boubli et al. (2008).

Cacajao hosomi Boubli et al. 2008 – Neblina uacari

Material: ZFMK_MAM_2002.032; adult male, received by Cologne Zoo 15.III.1974, † 23.IX.1992, carcass passed to ZFMK on 12.VI.1997; skull, postcranial skeleton.

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In 1974 the zoo received another individual of black-headed uacari from Venezuela, a male (Windecker 1975), which lived until 1992, the highest longevity recorded for a black-headed uacari (Weigl 2005). Published photographs of the animal, then identified as *Cacajao melanocephalus*, show this male at various stages of its life (Hick 1974; Mittermeier and Coimbra-Filho 1981; Pauly 2010). In a black-and-white photograph of the adult individual taken in 1985 by Hershkovitz (1987a: 30, fig. 16) it is identified as *Cacajao melanocephalus ouakary* (Spix, 1823). The diagnostic back pelage colouration of this subspecies given by Hershkovitz (1987a: 25) as 'Mid-back pale orange, golden or buffy and contrasted with reddish brown or tawny of lower back and thighs' was not present in this individual, though (cf. colour photographs of it mentioned subsequently), i.e. its subspecies identification is unfounded. Colour photographs taken subsequently, observations of the live animal by one of us (G.P.) and of the carcass revealed no orange tinge on the back at all. It is possible that this mistake slipped in on the occasion of the later subspecies identification based on the black-and-white photograph of Hershkovitz (1987a) as the animal's back seems brightened because of the lighting conditions when the photo was taken and/or the exposure time used.

Only after the publication of Boubli et al. (2008) it became evident that this uacari individual at Cologne Zoo belonged to the newly described species *Cacajao hosomi* Boubli et al., 2008 (Pauly 2010). Therefore, the common name proposed by its authors is used here. Various colour photographs of the live individual in publications by Cologne Zoo (zoo guides, title page of the journal 'Zeitschrift des Kölner Zoo' 26(4), 1983) and in Pauly (2010: 186, Abb. 6) support its identification as *C. hosomi* in showing its diagnostic colouration (Boubli et al. [2008]: fig. 3: 4, 5, p. 737 [description]): ' fur with bright reddish brown mid to lower back, thighs and tail, in contrast to Aracá black uacari specimens that have a much darker general coloration and to *C. melanocephalus* as redefined here, which present a golden brown general appearance.'

Chiropotes Lesson, 1840

Contrary to an earlier statement by Mittermeier & Coimbra-Filho (1981: 74) that '[t]he genus *Chiropotes* ... does not present any partieular problems', the species status of various taxa of *Chiropotes satanas* (Hoffmannsegg, 1807) sensu lato has been the subject of recurring discussions (Hershkovitz 1985; Rylands et al. 1995; Rylands et al. 2000; Groves 2001, 2005; Silva-Jr. & Figueiredo 2002; Bonvicino et al. 2003; Figueiredo et al. 2006; Veiga et al. 2008; Rylands & Mittermeier 2009; Ferrari et al. 2013; Silva-Jr. et al. 2013). As the diagnostic characteristics (nasal region and upper lip flesh-coloured, with whitish or yellowish hairs [Hershkovitz 1985]) of *Chiropotes albinasus* (I. Geoffroy and Deville, 1848) are clearly defined and unambiguously observable, its status as a distinct species has not been debated (Hill 1960; Chiarelli 1972; Napier 1976; Hershkovitz 1985; Groves 2001, 2005). Based on the taxonomic review of Hershkovitz (1985), in which he also described the new subspecies *Chiropotes satanas utahicki*, all other taxa of the genus *Chiropotes* were likewise classified as subspecies of *Chiropotes satanas* by subsequent authors (e.g. Rylands et al. 1995, 2000; Rowe 1996; Groves 2001).

By contrast, *Chiropotes albinasus, C. satanas*, *C. chiropotes*, and *C. utahickae* were regarded as distinct species by Bonvicino et al. (2003). Moreover, these authors listed *Chiropotes israelita* (Spix, 1823), the brown-backed bearded sakis of northwestern Brazil, north of the Rio Negro and west of the Rio Branco, as an additional species. In the primate chapter of 'Mammal Species of the World' Groves (2005) adopted this view, a procedure not followed by Noreonk (2007) who like Hershkovitz (1985) or Groves (2001) listed only two species in the genus, *C. albinasus* and *C. satanas*. Both last-mentioned authors regarded *israelita* as a synonym of *Chiropotes satanas chiropotes*. More recently, Silva-Jr. et al (2013) and Ferrari et al. (2013) supported a five species concept as proposed by Bonvicino et al. (2003), but they considered the taxon west of the Rio Braneo to be *Chiropotes chiropotes* and that east of the river to be *Chiropotes sagulatus* (Traill, 1821). There are no published data so far that clearly underpin the taxonomic conclusions of Ferrari et al. (2013) and Silva-Jr. et al. (2013) preventing us from drawing any final conclusions on the taxonomy of *Chiropotes*.

Bonvicino et al. (2003) explicated in detail why they consider the genus *Chiropotes* to include five distinct species and why the name *israelita* ought to be applied to the Rio Negro population, as also done by Boubli & de Lima (2009). The remarks of Bonvicino et al. (2003) in this latter context contain two material misapprehensions, though: 1. There is no substantial evidence that Spix's (1823: 11–12) original deseription of *Brachyurus israelita* (first in Latin and then in Freneh) refers to two different specimens as claimed by Bonvicino et al. (2003: 132). The specification of the type locality in the Latin text as 'Habitat ad Rio-Negro' (p. 11) and that – as opposed to this – at the end of the more detailed French text (p. 12) as 'On trouve ce singe vers le Pérou dans les forêts de Japura rivière laterale de Solimöens' must have been an error in the case of the latter statement since there is not a single record known for the occurrence of bearded sakis south-west of the Rio Negro (Hershkovitz 1985; Veiga et al. 2008; Ferrari et al. 2013; Silva-Jr. et al. 2013). Therefore we argue that this information cannot be taken as evidence of the existence of two different specimens on which the respective descriptions were based. Indeed, there is also no clear difference between characters de-

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tailed in the Latin text of Spix's (1823) original description of *Brachyurus israelita* and those described in the subsequent French text as claimed by Bonvicino et al. (2003). Furthermore, there is no indication for the (past) existence of a second specimen of bearded saki in the Spix collection (M. Hiermeier, ZSM, pers. comm. 2012). 2. Contrary to the assumption/statement of Bonvicino et al. (2003: 132) that the holotype specimen of *Brachyurus israelita* Spix, 1823 is lost, it is preserved in the collection of the Zoologische Staatssammlung München (ZSM) (Kraft 1983); pertinent information as well as its colour photo are available on the internet (see http:// www.zsm.mwn.de/mam/ptypes.htm, and http://www.zsm.mwn.de/mam/i/Brachyurus_israelita_34_D.jpg). Additional colour photos of the holotype specimen of *Brachyurus israelita* Spix, 1823, kindly provided by M. Hiermeier (cf. Fig. 1), show the typical coat colouration of *Chiropotes satanas chiropotes* as given in the key to the geographic forms of *Chiropotes* (Hershkovitz 1985: 13): 'Head, nape, lower arms, and legs blackish, sharply contrasted with orange of dorsum'.

Moreover, the statement by Bonvicino et al. (2003: 131) that '... Hershkovitz [1985] commented that there was no assigned *C. s. chiropotes* holotype or type locality. ' is formulated inappropriately and mistakable. In listing the type locality of *Simia chiropotes* as 'Said to be the upper Rio Orinoco south of the cataracts, Amazonas, Venezuela' according to Humboldt (1811) and in stating that the type is not preserved (i.e. was lost during its transport from South America to Europe), as already reported by Humboldt (1811), Hershkovitz (1985: 16) rendered the issue correctly. Thus, all available evidence supports the perception that *Chiropotes israelita* (Spix, 1823) is a junior synonym of *Chiropotes chiropotes* (Humboldt, 1811).

Shortly before the study by Bonvicino et al. (2003) was published Silva-Jr. & Figueiredo (2002) had reintroduced the name *Chiropotes sagulatus* (Traill, 1821), originally described from Guiana, as a distinct species. Bonvicino et al. (2003: 132) thereupon argued 'Silva-Jr. and Figueiredo (2002) recently proposed species status for *C. sagulatus*; however, they did not provide sufficient data to justify that taxonomic arrangement. ' Therefore Bonvicino et al. (2003) did not list *sagulatus* as a distinct species of *Chiropotes*. Husson (1957, 1978), in previous specific surveys of the mammal fauna of Guiana, had treated *sagulatus* as a synonym of *Chiropotes satanas chiropotes*, like most other authors of later pertinent technical publications (e.g. Hershkovitz 1985; Groves, 2001, 2005). Bonvicino et al. (2003) rightly pointed out that no substantial data – in effect no specific data at all – was presented by Silva-Jr. & Figueiredo (2002) in the published abstract of their contribution to the Xth Congresso Brasileiro de Primatologia and that therefore this abstract cannot be the proper basis for the resurrection of *sagulatus* as a distinct species. On the other hand, this does not rule out that the study of Silva-Jr. & Figueiredo (2002) underlying their congress contribution yielded data supporting such a view. In return, it does not have any relevance in supporting the view of Bonvicino et al. (2003) that the name *israelita* ought to be applied to the *Chiropotes* population west of the Rio Branco and north of the Rio Negro, and that it represents a distinct species.

Unlike Groves (2005) who adopted the concept of Bonvicino et al. (2003) in its entirety, a more recent review of the diversity of New World primates (Rylands & Mittermeier 2009: 40-41) pointed out that the cause of such discrepancies may be '... a possible confusion concerning the correct names.' Indeed, the distribution map published by Bonvicino et al. (2003: 125, fig. 1) shows localities of *Chiropotes satanas chiropotes* only considerably east of the Rio Branco in Brazil. All localities west of it and north of the Rio Negro are entered as *Chiropotes* sp. The locality of a 'possibly new taxon of *Chiropotes*' reported by Boubli (2002) and previously mentioned by Rylands et al. (2000) is still further northwest, close to the southernmost border of Venezuela. All these locality records are within the distribution range of *Chiropotes satanas chiropotes* as given by Hershkovitz (1985: 2, Fig. 1). In applying the name *israelita* to their 'new form of *Chiropotes*' the taxonomic views of Bonvicino et al. (2003) were apparently put forward without observance of the statement of the type locality ('On les trouve dans les vastes déserts de l'Alto-Orinoco, au sud et à l'est des Cataractes.') in Humboldt's (1811: 313) original description of *Simia chiropotes*. It is usually rendered as upper Rio Orinoco, south of the cataracts, Amazonas State, Venezuela (Cabrera 1961; Hershkovitz 1985; Groves 2001, 2005). Incidentally, the *Chiropotes* sp. individual from the lower Rio Marauiá, Amazonas, Brazil, reported and pictured in a colour photograph by Boubli (2002: fig. 3) clearly shows the typical coat colouration of *Chiropotes satanas chiropotes* as listed by Hershkovitz (1985: 13). The conclusion of Bonvicino et al. (2003: 129) that of the four *Chiropotes* taxa they studied the western two differ in dorsal coat colour (tawny-olive to buffy-brown in the westernmost versus orange or ochraceus in the eastern taxon) obviously contravenes that by Hershkovitz (1985: 17): 'All types of chromatic variation are fully intergrading and may occur in the same population. Geographic variation is not evident.' Of the original descriptions of the relevant *Chiropotes* taxa named, only the one of *israelita* (Spix 1823: 11–12) is sufficiently detailed (in its subsequent French version) to provide pertinent information in this respect: 'Les poils du dos sont très épais, peu longs, d'un roux jaunâtre, ceux des côtés d'un fauve plus foncé'. This clearly indicates a 'reddish-yellowish' hue of the back fur (as still detectable in the type specimen, see Fig. 1). Aside from the question whether *israelita* is a synonym of *chiropotes* there can be no doubt that its type locality places *israelita* into the westernmost form of bearded saki. So,

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Fig. 1–3. **1.** (Left) Back view of the mounted type specimen of *Brachyurus israelita* Spix, 1823 in the Zoologische Staaatssammlung München ZSM (Photo: M. Hiermeier, ZSM). **2.** (Center) Back view of mounted adult male *Chiropotes chiropotes* specimen ZFMK_MAM_66.001 (Photo: M. Weigt). **3.** (Right) Tanned skin of *Chiropotes* sp. specimen ZFMK_MAM_2008.244 (Photo: M. Weigt).

a reddish/orange tinge of the dorsal pelage colour may also be present in this population.

Gregory (2011) who kindly provided colour photos of living bearded sakis from Suriname opines that these animals have 'a much brighter orange dorsum' (visible in the photos) than the more western populations of bearded sakis (pers. comm. 2012); she uses the name *Chiropotes sagulatus* for them (Gregory 2011; Gregory & Norconk 2011). Concerning dorsal pelage colour the original description of *Simia sagulatus*, the Guianan bearded saki, states 'back well clothed with an ochry-coloured fur' (Traill 1821: 167), and in more detail (p. 168) 'The colour is brightest on the shoulders, where it is intermediate between wood-brown and yellowish-brown; and, on the back and sides, passes into the latter.' Traill (1821: 169) expressly states that these characteristics equally apply to five more specimens from the same geographical area (Demerara/Demerary in today's Guayana; originally a Dutch colonization area, later occupied by the British) as the holotype. Husson (1978: 210) describes the colour of the back pelage of nine *Chiropotes satanas chiropotes* specimens from Suriname as '... a dull brownish colour varying from yellowish umber to mummy brown.' which suggests quite some variation in this (distinctive?) character even among individuals from within a restricted portion of the distribution range of this taxon. Apart from colour fading likely to have occurred in museum specimens, these discrepancies may be due to differences in the relative coverage of the whole distribution range of *Chiropotes satanas* sensu lato surveyed and in over-all sample size and that for specific populations in these studies. Thereby the study of Hershkovitz (1985) is based on more specimens from a wider geographic range than any other published study so far.

Rylands & Mittermeier (2009: 41) stated that 'Silva-Jr. and Figueiredo (2002) argue that the form west of the Rio Branco is correctly *C. chiropotes*, according to its type locality, and the form to the east of the Rio Branco, extending through the states of Pará and Amapá, and into the Guianas (Guyana, Suriname, French Guiana) is *C. sagulatus* (Traill, 1821) from Demerara.'. However, they provided more detailed information on the issue than the published abstract by Silva-Jr. & Figueiredo (2002) actually contains. It may be assumed that it was obtained from these latter authors personally. The same is true of the statement in Veiga et al. (2008): '... *Chiropotes sagulatus* Traill, 1821, the latter representing the eastern form of *C. chiropotes*, which occurs to the east of the rio Branco, in Brazil, Suriname and the Guianas '. Unfortunately there are also no relevant data presented in the most recent publications of Silva-Jr. et al. (2013) and Ferrari et al. (2013) , which might support their taxonomic arrangement. Yet, to the best of our knowledge no 'proper' pertinent study has been published so far presenting evidence

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that *C. chiropotes* and *C. sagulatus* represent different species, or that they possess different distributional ranges. The name has recently been used, though, for bearded sakis from Suriname (e.g. Gregory & Norconk 2011) and the state of Pará (north of the Amazon), Brazil (e.g. Oliveira et al. 2009). The karyotypic differences between three *Chiropotes* taxa (not including *C. s. satanas* and *C. albinasus*) reported by Bonvicino et al. (2003), which in their view strongly indicate their status as distinct species, may actually support this concept. They found that the Rio Branco is the parting line of the two karyotypically different *Chiropotes* forms north of the Amazon.

There is little data on fur colouration in juvenile individuals (Hershkovitz 1985); so it is not possible to evaluate whether, to which extent and how this characteristic changes during ontogeny in the respective taxa. Anyhow, an in-depth comprehensive revision based on as large a number of specimens as possible from the entire distributional range, integrating classical morphological and modern genetic methods, in combination with all other evidence, is still required to clarify the taxonomy of the various forms of *Chiropotes satanas* sensu lato.

Chiropotes albinasus (I. Geoffroy & Deville, 1848) – White-nosed saki

Material: Three of five females of *Chiropotes albinasus* that lived at Cologne Zoo are in the ZFMK mammal collection. ZFMK_MAM_71.97b: adult female, † 1971, received from Cologne Zoo 1971; skull, flat skin. This is probably the individual the zoo received as a juvenile in 1968 (Windecker 1969). ZFMK_MAM_81.1815: adult female, † 17.VI.1981, received from Cologne Zoo VI-II.1981; skull, postcranial skeleton, flat skin. This is the individual 'Bella", the mother of four of the *Chiropotes* hybrids born at the zoo. This female arrived at the zoo in 1965 (Hick 1965a) and thus attained an age of >16 years. Most of the photos published of *Chiropotes albinasus* from Cologne Zoo (with its hybrid offspring) show this individual. ZFMK_MAM_89.480: adult female, † 01.IX.1988, received from Cologne Zoo IX.1989; skull, postcranial skeleton, flat skin. This is the female with the Zoo house name 'Bianca' which arrived there 08.X.1970 (Windecker 1971) and is the individual with the maximal longevity (> 18 years) attained by this species in any zoo (Weigl 2005). During the time this female lived at the zoo it gave birth to two offspring. Its estimated age of about 20 years noted by Weigl (2005) would imply that it was roughly 2 years old when it arrived at the zoo.

The first documented individual of *Chiropotes albinasus* in the care of Cologne Zoo, an adult female, arrived in 1965 (Hick 1965a; Pagel & Spieß 2011). In 1968 the zoo received a juvenile female (Windecker 1969, another female which arrived in 1966 only survived for a few months) and in 1970 another two juvenile females (Windecker 1971). Apart from popular print products of the Cologne Zoo with photos (black-and-white and colour) of several of these individuals (e.g. Hick 1968a: 35, 1973; Windecker 1969; front pages of the journal 'Freunde des Kölner Zoo' 9[3], 1966 and 11[2], 1968), photos of them also appeared in technical publications (Hick 1968b: Fig. 31; Roosmalen et al. 1981: 420; Hershkovitz 1985: 26).

Two of the white-nosed saki females gave birth successfully to hybrid young: a male out of a mating of *Chiropotes albinasus* female x *Chiropotes chiropotes* male in 1968 (Hick 1968a) and five more hybrids (2 males, 3 females) out of matings of *Chiropotes albinasus* female x *Chiropotes satanas* male in 1973 (2), 1975, 1976, and 1979; in 1978 one female had a miscarriage after such a mating. Like the first hybrid born in 1968 (Hick 1968a), some of the others born later were figured in photos, usually together with their mother (Kullmann 1976). The first hybrid born in 1968 is mentioned and also figured in technical publications (Roosmalen et al. 1981: 420; Hershkovitz 1985: 26). Hershkovitz's statement is not correct; the sire of this hybrid offspring was a *Chiropotes chiropotes* male (Becker, pers. comm. 2014). Four of the hybrid offspring were born by the female 'Bella', two by the female 'Bianca', and the same *Chiropotes satanas* male was the sire of 4 of the 5 hybrids born since 1973. A female hybrid born in 1975 lived at Cologne Zoo for more than 26 years (Weigl 2005). Occasionally one of these juvenile hybrids was wrongly labelled as *Chiropotes albinasus*, resp. no mention was made that the juvenile is a hybrid, e.g. in the publications of Kullmann (1976) and Mittermeier & Coimbra-Filho (1981: Fig. 53, p. 86) or in a figure legend (Zeitschrift des Kölner Zoo 17 (1), p. 1). The same is probably true for a colour photo of an adult 'female white-nosed saki (*Chiropotes albinasus*)' in Pauly (2010: 182, Abb. 1). If the date when the photo was taken (24.V.1990 as stated in the figure legend) is correct, this individual is a hybrid of *Chiropotes albinasus* female x *Chiropotes satanas* male because according to the zoo archives the last female white-nosed saki at Cologne Zoo died in 1988. In 1990 only two female hybrids were living at the zoo (Spieß, pers. comm. 2011; Becker, per. comm. 2012). Unfortunately, none of the altogether six hybrids born at the zoo was given to the ZFMK, another zoological museum or a scientific institute after their death.

Chiropotes chiropotes (Humboldt, 1811) – Red-backed bearded saki

Material: ZFMK_MAM_66.001; adult male, † 04.01.1966, received from Cologne Zoo 1966; skull, taxidermy mount (Fig. 2).

This individual arrived at the zoo as a juvenile in 1961 and was originally registered as a female which was later corrected. It is mentioned in Anonymous (1962) and

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shown at different ages in two black-and-white photographs, the earlier taken in May 1962, the later in September 1963 (Anonymous 1963: 87). Comparing both photographs the pronounced growth of the typical thick split tuft of hair on the head and that of the eponymous beard during the time span of about one year becomes obvious. Photos of *Chiropotes chiropotes* individuals kept at Cologne Zoo and published from 1964 onwards by zoo employees (Hick 1965a, 1966) very likely show other individuals of this species living there, as two more individuals arrived at the zoo in 1964 and 1965.

Description of the specimen (Fig. 2): As the specimen was on exhibit in the museum for a few decades, a general fading of its pelage colouration is likely to have occurred, especially in respect of possible yellowish/reddish hues that may have been present in the living animal. Following statements are made under this qualification. There is a marked contrast between the homogeneous light buffy ochre of the back and the dark brown to black colouration of the fur of the head, extremities and the tail. The colouration of the back extends into the flanks and the arms and thighs. On the upper arms pelage colour gradually changes into blackish brown of the more distal portion of the arms, on the upper side interspersed with lighter hairs. This colour change is more abrupt on the proximal part of the thighs. The backs of hands and feet are covered by brown hair. The venter is black. The fur colour on the head (with the beard and the split tuft of hair on top of it), nape and tail is basically black. The change in fur colour from the trunk to these body regions is abrupt.

Taking into account the unsettled taxonomic issues addressed earlier, the actual species identity of all relevant specimens that lived at Cologne Zoo cannot be verified resp. refuted retroactively, even more for those for which no photos are available and/or no material was given to the ZFMK or to another scientific institution after the animals' death. In addition, it is difficult to determine the species identity of juvenile bearded saki individuals retrospectively on the basis of photographic portraits with adequate certainty. Therefore we use the scientific names here under which they are registered in the zoo archives. According to these (Spieß, pers. comm. 2011; Becker, pers. comm. 2011) Cologne Zoo received four specimens of *Chiropotes chiropotes* between 1961 and 1977, three males and one individual of unknown sex which died a few months after its arrival whereas the other individuals all lived at the zoo for several years. One of these males (house name 'Ringo'), which arrived at the zoo as a juvenile in 1964, was the father of the first hybrid saki (mother *Chiropotes albinasus*) born at Cologne Zoo in 1968 (Hick 1968a). This male, given to a private animal husbandry in 1982, was figured in Hick (1968a: 38 & 39), van Roosmalen et al. (1981: 421; fig. 2); photos in Napier and Napier (1967: 121, plate 33) and Hershkovitz (1985: 14, fig. 8) probably also show it. Unfortunately, no remains of this individual are conserved in a scientific institution.

Chiropotes sp. – Bearded saki

Material: ZFMK_MAM_2008.244; adult male, † 1991, received from Cologne Zoo 5.IX.1991; skull, postcranial skeleton, flat skin (Fig. 3). Animal received by Cologne Zoo as a present from the defunct Dierenpark (zoo) Wassenaar, Netherlands, in 1978 and originally listed as *Chiropotes satanas chiropotes* in the zoo archives (Kullmann 1979). A colour photo of this individual alive, taken 24.V.1990 and referred to as *Chiropotes chiropotes*, was published by Pauly (2010: 183, Abb. 2). However, the dor-

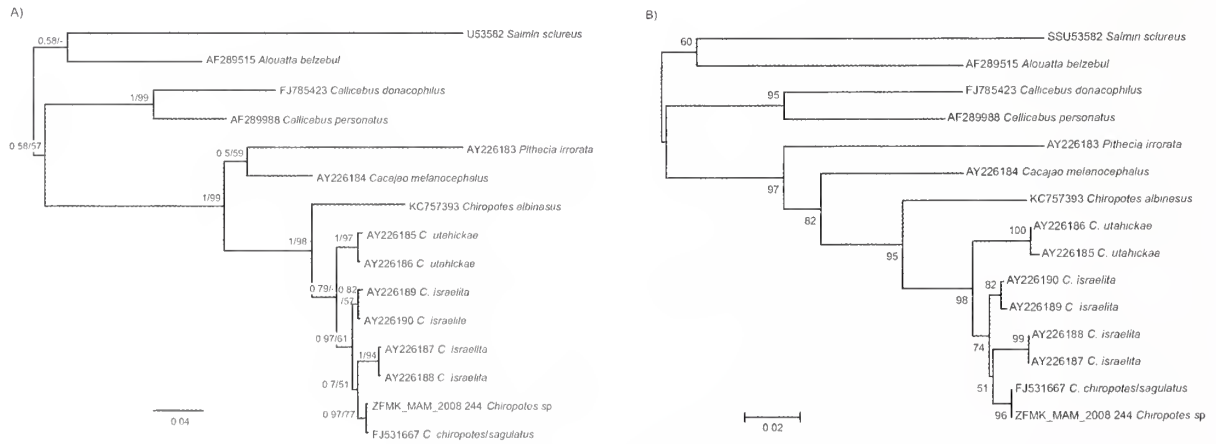

Fig. 4. Cytoehrome *b* phylogeny of the genus *Chiropotes*. A, Posterior probabilities of the Bayesian approach and bootstrap support values of the maximum-likelihood analysis before and after the slash, respectively. B, Phylogenetie relationships and bootstrap support values based on the neighbor-joining approaeh. Sample IDs eorrespond to GenBank aeeession numbers.

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sum of this specimen is light buffy to ochre contrasting the dark brown to blackish colour of the outer side of the upper and lower arms, legs, the fur of the head, and the outer side of the thighs. According to Hershkovitz (1985:13) characters of *chiropotes* and *utahickae* are described as 'Dorsum dominantly orange or pale brown to dark brown; outer side of upper arms and proximal part of outer side of thighs orange to dark brown, not blackish' and as 'Head, nape, lower arms, and legs blackish, sharply contrasted with orange of dorsum' in *chiropotes* vs. 'Head, nape, lower arms, and legs pale brown to dark brown and not sharply contrasted with brown of dorsum' in *utahickae*. Based on these external characters and the fact that no geographical origin is known, the species designation of the ZFMK specimen remains questionable. The results of our genetic study of this specimen is shown in Fig. 4. Except of relationships among *Cacajao*, *Pithecia* and *Chiropotes*, which cannot be correctly resolved based on the short cyt *b* fragment using the ML and Bayesian approaches, we obtained the same pitheciine phylogeny as Bonvicino et al. (2003). *Chiropotes albinasus* forms a basal taxon to all remaining *Chiropotes* members and *C. utahickae* forms a sister clade to *C. israelita*. However, irrespective of the phylogenetic approach and of uncertainties among basal pitheciine relationships, our sample from the ZFMK clusters together with the *C. chiropotes/sagulatus* sample from east of the Rio Branco causing paraphyletic relationships between *C. israelita* (sensu Bonvicino et al. 2003; also Darc et al. 2011) and *C. chiropotes/sagulatus* west and east of the Rio Branco, respectively (Fig. 4).

Chiropotes satanas (Hoffmannsegg, 1807) – Black bearded saki

Material: ZFMK_MAM_60.108; juvenile male, † 11.IV.1960, received from Cologne Zoo 20.VII.1960; taxidermy mount. The animal died at the zoo shortly after its arrival. A photo each of a juvenile individual of *Chiropotes satanas* from Cologne Zoo published in Hill (1960) and in Anonymous (1963) may be this animal but it may also show one of the other two juveniles of this species which the zoo received in 1954 resp. 1959, each of each survived for a short time only.

Description of the specimen: With the exception of the back which is covered with relatively long chestnut brown hair, the hair-coat of all other body parts is black. ZFMK_MAM_81.1819; adult male, † 04.VII.1981, received from Cologne Zoo VIII.1981; skull, skeleton, taxidermy mount. When this individual (house name 'Nicky') arrived at the zoo as a young juvenile on 26.VI.1970 it was originally registered as a female but this was corrected in the archives in 1971. Its black-and-white portrait taken soon after arrival was published (Windecker 1971: 4). No other photo published later of a bearded saki from Cologne Zoo or one kept in the zoo archives can be related to this individual with certainty; therefore its characters as an adult are not documented. It is the father of all hybrids of *Chiropotes satanas* and *Chiropotes albinasus* females born at Cologne Zoo between 1973 and 1978 (see above).

Description of specimen ZFMK_MAM_81.1819 (Fig. 5): As the specimen was on exhibit in the Museum for nearly two decades, the same general qualifications as for the *Chiropotes chiropotes* specimen ZFMK_MAM_66.001 apply in respect of an assessment of the coat colour of this individual. Moreover, it lost hair in the tanning process, especially on the back. This is likely to result in a changed perception of the colour of the back coat as compared to that of a living animal. Generally, there is no sharp contrast in coat colouration between different parts of the body. The colour of the head (with beard and split tuft of hair on top of it), nape, tail, extremities and backs of hands and feet is black as is that of the venter. On the back, shoulders, upper arms and thighs a lighter dull brown shines through the blackish hue, dominating the general colour impression of the back.

Whereas the last in-depth revision of the genus *Chiropotes* by Hershkovitz (1985) listed two subspecies of *Chiropotes satanas* in addition to the nominate form, the current notion is that *Chiropotes satanas* represents a distinct species with no subspecies (Silva-Jr. & Figueiredo 2002; Bonvicino et al. 2003; Groves 2005; Figueiredo et al. 2006; Rylands & Mittermeier 2009; Ferrari et al. 2013;

Fig. 5. Back view of mounted adult male *Chiropotes satanas* specimen ZFMK_MAM_81.1819. The hair on the back is thinner than in the living animal (Photo: M. Weigt).

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Silva-Jr. et al. 2013). As detailed above, the two remaining former subspecies and an additional one are accorded species rank each as well. We adopt this concept here. As in the case of *Chiropotes chiropotes* we have to rely on the species determinations in the Cologne Zoo archives for those individuals for which no detailed documentation and/or collection material is available, appreciating the fact that these may have been wrong, especially in young juveniles which are difficult to identify as to species in *Chiropotes satanas* sensu lato. Between 1954 and 1970 Cologne Zoo received 4 individuals of *Chiropotes satanas*, all as young juveniles: two males, one female and one individual the sex of which was not established with certainty and which died soon after its arrival. Only the male individual received by the zoo in 1970 lived to adulthood.

Concluding taxonomical remarks on *Chiropotes* specimens in the ZFMK collection

***Chiropotes chiropotes* ZFMK_MAM_66.001:** We consider this species identification to be well-founded. In consideration of the qualifications of such an appraisal the available evidence still documents an extensive similarity of this ZFMK specimen with the type specimen of *Brachyurus israelita* Spix, 1823 and the specimen referred to as *Chiropotes* cf. *satanas* in a colour photograph in Boubli (2002), both of which are synonyms of *Chiropotes chiropotes*.

***Chiropotes* sp. ZFMK_MAM_2008.244:** Our cyt *b* phylogeny shows a close genetic relationship of this specimen to an individual from Rio Trombetas east of the Rio Branco, i.e. within the distribution of *C. sagulatus* according to Ferrari et al. (2013) and Silva-Jr. et al. (2013). However, their description of *sagulatus* is 'Dorsum and upper limbs … are orange to reddish-brown. Head, nape, lower arms and legs are blackish' (Ferrari et al. 2013: 481), which does not fit to the general appearance of the ZFMK specimen. Despite the small amount of samples analysed, the unknown origin of the ZFMK specimen and of the low support values in reconstructed phylogenies, our data allow us to draw some preliminary conclusions. Our results support the existence of different colour variants within groups of closely related individuals and possibly within the same geographic region, here within the *Chiropotes* form occurring east of Rio Branco. This finding corresponds to the statement by Hershkovitz (1985) that no clear geographic separation between different pelage variants exists. Furthermore, our molecular results indicate that most probably both *israelita* and *sagulatus* do not deserve species status and may represent synonyms of *Chiropotes chiropotes*. Therefore, we highly recommend further genetic studies on diverse *Chiropotes* samples from a variety of geographical areas, including *Chiropotes satanas* to clarify the phylogeny of the genus, and most importantly, to allow final taxonomic conclusions.

***Chiropotes satanas* ZFMK_MAM_60.108:** There is very little reliable information on coat colour of juvenile individuals of *Chiropotes satanas* sensu lato. To the best of our knowledge no such data have been published for juvenile *Chiropotes satanas* sensu stricto; based on the relevant details provided for *Chiropotes chiropotes* (Hershkovitz 1985: 17) it seems possible that this ZFMK individual actually represents the latter species.

***Chiropotes satanas* ZFMK_MAM_81.1819:** In spite of the reservations with respect to the assessment of the fur colouration of the living animal, in light of the condition of this taxidermy mount we consider this species identification to be well-founded.

Pithecia Desmarest, 1804

The first revision of the genus *Pithecia* by Hershkovitz (1979) recognized four species, a concept also followed by Buchanan et al. (1981). The current taxonomy of this genus as adopted by Groves (2001, 2005), Rylands & Mittermeier (2009) and Ferrari et al. (2013) is based on the earlier and more detailed revision by Hershkovitz (1987b) in which he recognized five species. However, there is also evidence that a further revision of this genus is required (Marsh 2004, 2006, pers. comm. 2012). In her final revision (Marsh 2014) 16 species are recognized.

Pithecia mittermeieri Marsh, 2014 – Mittermeier's Tapajós saki

Hershkovitz (1987b: 427, Fig. 25) figured an adult male *Pithecia irrorata irrorata* (house name Sascha) from Cologne Zoo. Since its arrival at Cologne Zoo in 1966 until its death on 20.I.1981 it was registered as *Pithecia monachus* in the Zoo archives. Hick (1968b) published its black-and-white portrait and later on another photograph/portrait in colour (Hick 1973) under this name. The best photographic documentations of this individual referred to as *Pithecia monachus* are two black-and-white photographs and a colour photo in Tylinek and Berger (1984) and colour photos in several official guides of Cologne Zoo in the 1970es (Fig. 6). According to Weigl (2005), who listed this animal under the scientific name *Pithecia irrorata irrorata*, it reached the highest longevity known of any individual of this species in human care (more than 14 years and 7 months). In the recent revision of the genus this individual is identified as *Pithecia mittermeieri* sp. nov. (Marsh 2014: 5, Table 2). Regrettably no zoological material of it is preserved in the ZFMK, another zoological museum or a scientific institution.

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Fig. 6–7. **6.** (Left) Adult male *Pithecia mittermeieri* Marsh, 2014 in the Zoo Cologne; this animal may be the one shown in figure 7 (Photo: P. De Prins, reproduced from 'Wegweiser durch den Zoo Köln', c. 1976). **7.** (Right) Adult male specimen of *Pithecia aequatorialis* (lying individual on the left) (ZFMK_MAM_81.1818) in the Zoo Cologne (1973 or later); the individual sitting on the right may represent *Pithecia mittermeieri*, possibly the same animal as shown in figure 6 (Photo: G. Peters).

***Pithecia aequatorialis* Hershkovitz, 1987 – Equatorial saki**

Material: ZFMK_MAM_81.1818; adult male, † 1981 (?), received from Cologne Zoo VIII.1981; skull, postcranial skeleton, flat skin (Fig. 7, the living animal).

This specimen has the diagnostic pelage characteristics of *Pithecia aequatorialis*. It was received from Cologne Zoo as *Pithecia monachus* and classified as such in the ZFMK collection then. After the publication of the second revision of the genus *Pithecia* by Hershkovitz (1987b) the species determination of this specimen was reassessed and subsequently classified as *Pithecia aequatorialis*. This identification was confirmed by L. Marsh (pers. comm. 2011) on the basis of several colour photos of the ZFMK skin. Unfortunately, there is no photograph of the living animal or written record in the Cologne Zoo archives which can be unambiguously assigned to this individual (Spieß & Becker, pers. comm. 2011). However, a photograph by R. Mittermeier (in Marsh 2014: fig. 49) may show this individual.

Several individuals classified as *Pithecia monachus* lived at Cologne Zoo during the second half of the 1970's. Apart from the male individual of *Pithecia mittermeieri* mentioned above (and then wrongly classified as *P. monachus* at the zoo) none of the black-and-white photographs of '*Pithecia monachus*' individuals archived at the zoo shows an animal with the typical pelage characteristics of *Pithecia aequatorialis* males. In the five year period from 1977 until 1981 four individuals classified as *P. monachus* died at Cologne Zoo, one of which was the misidentified *P. mittermeieri* (Becker, pers. comm. 2012). The only photograph on file of a '*Pithecia monachus*' individual at the zoo which died between 1977 and 1981 (other than the *P.mittermeieri* male mentioned) is one taken in 1969 of a '*monachus*' that died in 1979. So, there is definitely no 'trace' of the ZFMK *Pithecia aequatorialis* adult male in the Cologne Zoo archives. A colour slide (Fig. 7) taken by one of us (G.P.) shows this individual alive (or another male of this species if there were more than one in the zoo at that time) and therefore is additional proof of its species identification (confirmed by L. Marsh, pers. comm. 2013, based on this slide). The photo can be roughly dated to the time period 1973 to 1977 because it was taken in the Lemur House of Cologne Zoo which opened in 1973, and on written entries in the animal records at the zoo.

This species was described as new to science after all *Pithecia* individuals (other than *P. pithecia*) at Cologne Zoo had been dead already for several years. In his earlier revision of the genus Hershkovitz (1979: 15, fig. 5) had figured a study skin of an adult male *Pithecia* as *P. monachus*, only to revise his taxonomic assessment of the same individual in the later revision and identify it as the new species *Pithecia aequatorialis* (Hershkovitz 1987b: 408, fig. 16). Diagnostic characteristics differentiating males of *aequatorialis* from male *monachus* are a ruff of orange hair and a horseshoe-like area of relatively short white dense hair around the sparsely haired facial disk in the former species (L. Marsh, pers. comm. 2011, Marsh 2014).

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CONCLUDING REMARKS

Our paper is based on only a few Neotropical primate specimens from Cologne Zoo in the ZFMK mammal collection. Nevertheless, it provides an example of the value and of the conclusions that can be drawn from collections obtained from zoos and housed at zoological museums (or similar scientific institutions). The ZFMK received also primate specimens from other zoos, such as Duisburg and Frankfurt (see Appendix), which may be equally important. In the first place it shows that even today zoos may have scientifically important specimens in their care, sometimes unnoticed by the scientific community. To avoid such cases as far as possible it is desirable that zoos and zoological museums intensify their cooperation (cf. Gippoliti & Kitchener 2007). It is important that zoos are aware of the potential scientific importance of specimens in their care and try to gather and archive all pertinent information during the lifetime of such specimens: geographical origin (if known or if it can be traced back), colour photos at different ages, body mass, measurements, reproductive history, ISIS reports, CITES papers (if applicable), references of publications dealing with the specimen (if the specimen is mentioned/figured in a publication), or other. This is, however, more than usually recorded. It may be useful to agree on a uniform database, so that information from different zoos can be more easily combined.

Taking into account relevant veterinary and other legal regulations the most reasonable procedure would be that zoos pass such specimens immediately after their demise to a zoological museum. The condition of the specimen should thereby allow all standard museum procedures, e.g., collection of tissue and hair samples, preparation of skin and skeleton or any other method of conservation. Appropriate storage of such samples should allow subsequent genetic analyses. Furthermore, copies of all documentation of that specimen compiled at the zoo during the animal's lifetime should be provided, including veterinary treatments. A scientifically important specimen in/from a zoo can only maintain its 'voucher status' and its significance posthumously as a subject for later studies, if its remains are housed and curated properly in a zoological museum or another appropriate scientific institution in the long run. This ought to be in the genuine interest of the respective zoo and definitely is so for the scientific community, especially if specimens have been referred to in the scientific literature like several *Chiropotes* individuals from Cologne Zoo in the ZFMK mammal collection, which are listed here. The *Pithecia mittermeieri* individual discussed above exemplifies the deplorable ultimate loss of information and research options if this procedure is not followed after an animal's death. On the other hand, the specimen of *Pithecia aequatorialis* in the ZFMK collection detailed before illustrates that steady contact and information exchange between zoos and zoological museums may have resulted in the timely awareness of the significance of this individual, especially in the context of a taxonomical revision of the genus *Pithecia*.

Zoological museums with their taxonomic expertise ought to interact with (neighbouring) zoos regularly, including the offer to provide advice on matters of taxonomy if requested. Once a specimen that died in a zoo is given to a museum, the museum has the responsibility of its proper long-term documentation and curation, preserving as much and diverse material of the animal as possible to enable diverse kinds of (future) studies. This includes the repeated verification of a specimen's species identity on the basis of the most recent pertinent publications to ensure its scientific significance. If a specimen is affected by a taxonomical change, either during its lifetime or posthumously, this information ought to be circulated among the institutions involved.

Both zoos and zoological museums can only benefit from a closer cooperation as a means to increase taxonomic expertise and awareness of taxonomical problems as well as the proper long-term conservation of scientifically interesting and important zoological specimens.

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APPENDIX

List of Pitheciidae in the collections of ZFMK Bonn.

Cacajao calvus. ZFMK_MAM_66.612 (Cologne Zoo 1966); ZFMK_MAM_81.1816 (Cologne Zoo 1981); ZFMK_MAM_2001_147 (Cologne Zoo 1993); ZFMK_MAM_2012.427 (Cologne Zoo 2008).

Cacajao hosoui. ZFMK_MAM_2002.032 (Venezuela/Cologne Zoo 1992).

Chiropotes albinasus. ZFMK_MAM_71.097 (Cologne Zoo 1971); ZFMK_MAM_81.1815 (Cologne Zoo 1981); ZFMK_MAM_89.480 (Cologne Zoo 1989).

Chiropotes chiropotes. ZFMK_MAM_66.001 (Brazil/ Cologne Zoo 1961). ZFMK_MAM_74.155 (Duisburg Zoo 1974).

Chiropotes satanas. ZFMK_MAM_60.108 (Cologne Zoo 1960); ZFMK_MAM_ 81.1819 (Cologne Zoo 1981).

***Chiropotes* sp**. ZFMK_MAM_2008.244 (Cologne Zoo).

Pithecia aequatorialis. ZFMK_MAM_81.1818, male (Peru/ Cologne Zoo 1981).

Pithecia inusta. ZFMK_MAM_ 87.730, female (Peru, Panguana 1973; Hutterer et al. 1995).

Pithecia pithecia. ZFMK_MAM_71.097, male (Cologne Zoo 1971); ZFMK_MAM_2012.009, male (Frankfurt Zoo 2008).

***Pithecia* sp.** ZFMK_MAM_75.108, female (Duisburg Zoo 1975).

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(this volume, pp. 173–187).

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